Teaching in New Haven:
The Common Challenge

A Report of the Yale-New Haven Teachers Institute
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Preface

James R. Vivian

In 1982 Fred M. Hechinger wrote his first of several columns in *The New York Times* on the Yale-New Haven Teachers Institute. He described the Institute's establishment in 1978 as signaling a "reversal of the twenty-year breach between universities and schools." The next year the late Yale President A. Bartlett Giamatti and Ernest L. Boyer, President of the Carnegie Foundation for the Advancement of Teaching, convened a national conference of Chief State School Officers and college and university presidents, which the Institute organized at Yale. At the meeting, attended by representatives of thirty-eight states, the Institute was presented as an example of how universities can and must assist in strengthening teaching in the nation's schools. In 1986, when the Institute held a conference on "Strengthening Teaching Through Collaboration," Mr. Hechinger said that "the list of participants in the conference showed collaboration's rapid spread." In 1990 he wrote in *The New York Times* that the endowment of the Yale-New Haven Teachers Institute—the result of a highly creative $2 million challenge grant by the DeWitt Wallace-Reader's Digest Fund, which made the Institute the first collaborative program of its type to be permanently established—marked the beginning of a "new era" in university-school relationships.

During the 1980s there was, as Mr. Hechinger's columns indicate, a gratifying amount of attention to the Institute's work in New Haven and to the growing movement for university-school collaboration, as well as the opportunity for the Institute to assist other universities and schools in the development of similar programs. Representatives of the Institute were often asked to explain how school teachers could take from an Institute seminar with a Yale faculty member something practical to use in their own classrooms. The purpose of the present volume, then, is to provide concrete examples of how several teachers of diverse subjects and grade levels have used Institute seminars to develop materials for their own teaching.
Background

In 1980 two national panels issued their findings on the state of student learning in the humanities and the sciences: a joint National Science Foundation Department of Education study spoke of “a trend toward virtual scientific and technological illiteracy” and the Commission on the Humanities concluded that “a dramatic improvement in the quality of education in our elementary and secondary schools is the highest educational priority in the 1980s.” The commission called for curricula to teach children to read well, to write clearly, and to think critically. They also found that “the need to interrelate the humanities, social sciences, science and technology has probably never been greater than today.”

These national problems in public education, further described in scores of subsequent studies and reports, are of concern to Yale as to universities generally, and Yale’s reasons for becoming involved in seeking solutions therefore transcended its sense of responsibility to the New Haven community. As President Giamatti pointed out in an interview on the David Susskind television program on December 7, 1980, “it is profoundly in our self-interest to have coherent, well-taught, well-thought-out curricula” in our local schools and in secondary schools throughout the country.

Yale had acted on such a view as early as 1970, when the History Department began the History Education Project (HEP), which assisted a number of New Haven social studies teachers in developing improved curricula for courses in American history, world area studies, and urban studies. Although involving fewer than twenty teachers each year, the History Education Project enjoyed a good reputation among school teachers and with the administrations of the University and the Schools. In 1977 the Secretary of the University, Henry Chauncey, Jr., then responsible for Yale’s community relations, called HEP “the most solid, the most vital” educational link between Yale and New Haven. It provided, in fact, one of the few occasions for the University and School administrations to meet about a joint endeavor. HEP had been undertaken with a grant from the American Historical Association (AHA), which until 1973 funded a number of such projects across the country. The New Haven project was later continued with local and state support; and by 1977 it was the only project the AHA had helped to establish that was still in existence, its $10,000 annual budget provided in equal shares by the University, the Schools, and New Haven’s community foundation. There was, thus, an eight-year record of a well-regarded relationship among university faculty members and school teachers to which both institutions had a financial commitment, albeit small.
Perhaps most important, the participating school teachers and members of the Yale History Department had discovered what they stood to gain from working with each other. They became the nucleus of the groups that planned the present Institute. They were persuasive, within the University and the Schools, in enlisting administrative support. They also solicited the interest of their colleagues in their own and other University and School departments. Because of their previous collaborative experience and their standing in their respective institutions, they were able to convince their administrations and their teaching colleagues that such an undertaking would be worthwhile and mutually advantageous.

History

In these ways the success of HEP created favorable conditions for planning a more ambitious and demanding program that would include additional disciplines. For the administrations of Yale and the Schools, the earliest discussions in 1977 focused on which of the Schools’ many needs might be most usefully addressed by the University’s resources. In what areas did the Schools have significant needs and the University complementary strengths? What was central enough to the mission of both institutions to enable us to construct a real partnership of allies in league to improve our community’s public schools? Which problems of the Schools were recurring, and which University resources enduring, so that the program might be of benefit to the Schools over the longer term? These questions were addressed at a time of enormous pressures on the budgets of Yale, the City, and the Schools. Even in better times, financial resources would never fully match our ambition to construct a highly productive partnership. The overriding question was how we might together apply limited resources in an intensive way where the need was greatest.

We explored these questions in the context of developing a proposal to the National Endowment for the Humanities (NEH) to expand the history project, to include additional disciplines in the humanities, to increase the number of teachers involved, and to make the new program more rigorous. Since 1978 the NEH has provided indispensable support for the Institute. The development of proposals to the NEH and others, in fact, has demonstrated that proposal writing itself has certain beneficial results: it establishes a need to clarify and obtain agreement on objectives, and it imposes a deadline for making decisions.

Teachers and administrators from the University and the Schools soon reached a consensus: the relationship between the University and the Schools must be both
prominent and permanent within any viable larger relationship between Yale and New Haven, and of the many ways Yale might aid New Haven none is more natural than a program that shares Yale's educational resources with the Schools. Because student needs change, scholarship develops, and new educational policies are established by the school system and each level of government, school curricula undergo frequent revision and teachers are reassigned to teach subjects they have not taught recently, or ever before. Because of Yale's strength in the academic disciplines, all agreed that the University could most readily aid the Schools by assisting in the further preparation of curricula and teachers in the subjects they teach, and by helping teachers to keep abreast of new developments in their fields.

Our intent was therefore not to create new resources at Yale; rather, it was to expand and institutionalize the work of University faculty members with their colleagues in the Schools. Even at this early stage, both Yale and the Schools sought a course of action that might have a substantial impact. The Superintendent of Schools, Gerald N. Tirozzi, and the Board of Education asked that the expansion of the program begin with the addition of seminars in English, the subject in which they saw the greatest need. The objective was eventually to involve as many teachers as possible and to include a range of subjects that would span the humanities and the sciences, so that the program might address school curricula, and thus students' education, broadly.

In 1978, then, the Yale-New Haven Teachers Institute was established as a joint program of Yale University and the New Haven Public Schools, designed to strengthen teaching and thereby to improve student learning in the humanities and the sciences in our community's middle and high schools. That year, the President of Yale, the Superintendent of Schools, the Mayor of New Haven, and the Institute Director held a news conference on the program. This was the first news conference held by a Yale President and a New Haven Mayor in over a decade, and the only one in memory that concerned public education in New Haven. At that time Mayor Frank Logue commented that the Institute represents "a combined activity that is in the mainstream of both our enterprises," not something made "out of whole cloth."

Since 1978 the Institute has benefited from a time of unusual harmony and good will between the University and the Public Schools and the City administration. Moreover, because it was founded well before the widespread public attention that since 1983 has been paid to our nation's public schools, it was not subjected to intense scrutiny before it could begin to have sound evidence of the results of its program. Indeed, our problem in the earliest years was in obtaining any public recognition at all for teachers' work in the Institute.
In September 1986, the new President of Yale, the new Mayor of New Haven, the new Superintendent of Schools, and the Institute Director held a news conference to accept the Teachers Institute's third grant from the National Endowment for the Humanities. The announcement provided an occasion, similar to the news conference in 1978, for President Benno C. Schmidt, Jr., three days after his inaugural, to hold his first news conference together with Mayor Biagio DiLieto and Superintendent of Schools Dr. John Dow Jr. Mayor DiLieto said then the Institute "is an excellent illustration of the kind of cooperation that exists between the City administration and Yale University, and it speaks well for our efforts to maintain that relationship at a very high level." Superintendent Dow said that "the improvement of our school system can be directly related to the kind of involvement that we have here." President Schmidt said that "among the many ways in which Yale University seeks to be a good and active citizen of New Haven, the Yale-New Haven Teachers Institute is one of our great successes."

These are among the reasons why Yale announced in 1990 a plan to build an adequate endowment for the Yale-New Haven Teachers Institute. By endowing the Institute, we want to transform it into a permanent and central function of a university which is committed to collaborating with school teachers and to strengthening teaching and learning in local schools and in schools across the country. We also want to affirm that Yale believes that such collaboration is directly in its own self-interest. We hope that this may be influential with other institutions and schools. At a time when universities across the country need to be more deeply involved in strengthening teaching in schools, endowing the Institute demonstrates one way for a faculty of arts and sciences to contribute effectively to teachers' continuing education. We therefore intend to encourage the permanent establishment of similar institutes at other colleges and universities across the country.

Since its founding in 1978 the Teachers Institute has become by far the most comprehensive, intensive, and sustained collaboration of Yale faculty members with public school teachers. Between 1978 and 1991 the Institute has offered 88 different seminars in the arts and humanities, the social sciences, mathematics, and the physical and life sciences. Seventy-three Yale faculty members have given Institute talks and led one or more seminars. More than 300 individual school teachers have completed the program successfully from one to fourteen times. Through the program, Fellows have developed 708 individual curriculum units which are taught widely in school courses.
The Annual Program

Teachers play a leading role in determining how the Institute can help them meet the needs of all their students, not only those who later will enter college. Each year as many as eighty New Haven school teachers of English, history, foreign language, art, math, and science become Fellows of the Institute to work with Yale faculty members on topics the teachers themselves identify. The Institute does not involve a special group of teachers who teach a special group of students; rather, it seeks to involve all teachers, grades 3 through 12, who can demonstrate the relationship of their proposed Institute work to school courses they teach.

Culminating with the Fellows' preparation of new materials that they and other teachers will use in the coming school year, the Institute's annual program lasts almost five months and includes talks, workshops, and seminars. The talks are intended to stimulate thinking and discussion and to point up interdisciplinary relationships in scholarship and teaching. Presenting Institute guidelines for curriculum units, the workshops explore the Fellows' own approaches to writing a curriculum unit and stress the main audience for whom Fellows are writing: other teachers. The Institute encourages Fellows to write their units in first person—in the voice of an experienced classroom teacher—addressing other teachers in and beyond the seminar. This extends the operation of collegiality within the seminar to encompass other colleagues in the schools who might adapt the units to their own teaching.

As Thomas R. Whitaker describes in his introduction to the present volume, the leader and Fellows in each seminar must face together the challenge of balancing the teachers' further preparation in the seminar subject with their development of teaching materials for school courses. Thus, each seminar addresses the fundamental educational issue of the connection between the teacher's preparation and students' learning. Our experience with HEP taught us that this was something too vital to be left to chance. We cannot simply assume that the teacher's new knowledge will be conveyed to students. By requiring the writing of a curriculum unit, we insist that teachers and their seminar leader examine together how that knowledge can be effectively introduced to students in the schools. The units themselves therefore mirror the collaborative nature of the Institute, combining as they do both current knowledge of a field and classroom experience. The Institute does not accept "auditors" or teachers who are unwilling to write a curriculum unit. The teachers who serve as Coordinators within each of the seminars follow the progress of other Fellows in developing their
units and meeting due dates; and any Fellow who does not submit a finished curriculum unit is considered not to have completed the program successfully.

The materials that the Fellows write are compiled into a volume for each seminar and deposited in school libraries throughout New Haven. As compared with the loose-leaf files in which only one set of all materials developed in the HEP were kept, Institute units contain an organized approach to teaching a specific topic, bound with related essays, and circulated widely to other teachers. Thus teachers’ work is documented and made available to many more teachers throughout the school system over an extended period of time. The Institute in effect publishes the units, providing all Fellows a type of professional opportunity not ordinarily available to them. Seminar members and the teachers who serve during nine months of the year as Representatives of the Institute for all New Haven schools promote widespread use of these materials by their colleagues.

Results for Teachers and Students

Many evaluations have documented the efficacy of the Institute’s approach in increasing teachers’ knowledge of their disciplines, enhancing their professional morale and confidence in teaching the subjects they study and the curricular material they prepare in the Institute, heightening their own self-fulfilling expectations of students’ capacity to learn this material, and encouraging them to remain in teaching in New Haven. The curriculum units Institute Fellows write are used widely and effectively by themselves and many other teachers, and students’ attention, motivation, and mastery are improved as a result.

In fact, seventy percent of all teachers who have been Institute Fellows are currently in teaching or administrative positions in the New Haven Public Schools. Between 1986 and 1990, from forty-four to forty-eight percent of Fellows each year said that the opportunity to participate in the Institute had influenced their decision to remain in teaching in our local public school system.

Acknowledgments

We are grateful to numerous individuals and organizations who have made possible the present volume. More than seventy-six local and national foundations and corporations have provided gifts and grants which—together with funding
from Yale University and the New Haven Public Schools—supported the Institute seminars offered since 1978 through which teachers wrote the original versions of the curriculum units which are included here. Although a complete listing of these sponsors appears in the appendix, I should credit in particular the invaluable support which has been provided since 1978 by the National Endowment for the Humanities for our work in the humanities, and since 1985 by the Carnegie Corporation of New York for our work in the sciences. In addition, I especially want to acknowledge the role of the Carnegie Corporation of New York in encouraging the Institute to undertake the preparation of the present volume and in supporting its editing, revision, and production. This volume was first released for discussion at the December 1991 Yale Conference on “University-School Collaboration: Preparing Teachers and Curricula for Public Schools,” a meeting of teachers and administrators from across the country made possible by major support from the DeWitt Wallace-Reader’s Digest Fund. The material presented here, however, does not necessarily reflect the views of the funding agencies.

We were particularly fortunate that Thomas R. Whitaker, Frederick W. Hilles Professor of English and Professor of Theater Studies, who has himself led nine Institute seminars—greater than the number led by any other Yale faculty member—agreed to edit this volume and advise the individual authors in the revision of their curriculum units. We appreciate, too, that in many cases the Yale faculty members who advised the development of the original units conferred with the authors on updating and extending the original statements of their teaching plans. Most importantly, the authors themselves took the time during an unusually demanding school year to undertake the process of revision for this publication, in order to make their experience in the Institute more widely available to their colleagues in other communities across the country.

This volume is the Institute’s first venture in desktop publishing; four individuals not only assisted in the production of the present book but also increased the Institute’s capacity to undertake similar projects in the future. Three of these individuals were Yale undergraduates employed by the Institute during the summer of 1991: Adam W. Schmitzer designed the book and laid out each page; Arthur K. Chung scanned the illustrations which appear here and solved more than one computing problem that could have stalled the whole project; Kimberly E. Kessler assisted by word processing and proofreading several of the units. Erica C. Brossard, Administrative Assistant in the Institute, worked in all the areas mentioned above and completed the volume after summer’s end. Janet
Russell, Senior Administrative Assistant in the Institute for more than ten years, made the arrangements for printing this edition of the book.

This volume, like the Institute itself, is therefore a collaboration among many individuals with diverse responsibilities and backgrounds, each of whose contributions was essential to the finished work. All were guided, I believe, by the expectation that the curriculum units presented here will make the school teacher's experience of participation in the Yale-New Haven Teachers Institute more meaningful to our colleagues in other institutions and schools. We further hope that it will add to their understanding—as well as our own—something valuable about the ways in which public school teachers and university faculty members can work together through such an Institute, as they face in common the challenge of strengthening teaching and learning in an urban community’s public schools.

James R. Vivian

New Haven
October 1991

Notes


6These results are presented in some detail in “Preparing Teachers and Curricula for Public Schools: A Progress Report on Surveys Administered to Teachers, 1982-1990,” by the Yale-New Haven Teachers Institute, 1991.
Introduction

Thomas R. Whitaker

1

This volume presents twelve of the more than six hundred curriculum units that have been prepared since 1978 by Fellows of the Yale-New Haven Teachers Institute. Although these selected units undoubtedly contain both research and pedagogical strategies that teachers elsewhere might well adapt to their own purposes, we do not offer them as plans to be followed or models to be imitated. Their importance is more fundamental and more complex. They stand here as examples of the distinctive process of individual curriculum development in which the Fellows of the Institute have been engaged.

As James R. Vivian stated in his introduction to Teaching in America: The Common Ground, the Institute has been guided by four principles: a belief in the importance of the classroom teacher and of teacher-developed materials for effective learning; an insistence that teachers of students at different levels interact as colleagues, addressing their common problems; a conviction that any effort to improve teaching must be "teacher-centered," and a consequent reliance upon Institute Coordinators, teachers who meet weekly with the Director and constitute an essential part of the program's leadership; and a certainty that the University can assist in improving the public schools only if it makes a significant and long-term commitment to do so. The Institute therefore makes use of no curriculum experts in the usual sense, no short-term workshops, no regular graduate courses in methods or content. Instead, it brings together teachers from the New Haven public schools and the Yale University faculty in a genuinely collaborative endeavor.

Each year the Director and the Coordinators determine, through discussion among themselves and consultation with other teachers in the schools, the areas in which Institute seminars might most usefully be offered. (In recent years, funding has made possible four seminars in the humanities and social studies, and two seminars in sciences and mathematics.) Yale faculty who might teach in
the selected areas are then invited to submit seminar proposals. After further canvassing other teachers, the Coordinators select the seminars to be offered. It is understood that each will be an opportunity for shared study and also the occasion for the preparation of curriculum units that the Fellows plan to use in the ensuing year.

The balance between academic preparation and classroom application, and between common study and individual projects, will be understood somewhat differently in each seminar. And there are no doubt many ways of crossing the somewhat artificial boundary between “subject” and “pedagogical method.” In the main, however, the collegiality that is so important to the Institute rests on the assumption that the member of the Yale faculty who leads the seminar will bring some special competence in an academic field, and that the Fellows (who are not “students” but full members of the Yale community, with library privileges and stipend) will bring their special competencies in the aims, needs, and problems of their home classrooms.

After selecting the seminars for the year, the Coordinators invite applications from teachers in the public schools. (Originally limited to high-school teachers, the Institute has expanded to include teachers from middle schools and, most recently, elementary schools.) Any successful application must contain a preliminary proposal for a curriculum unit that might be prepared in conjunction with a seminar, and authorization by the teacher’s supervisor to incorporate such a unit in the teaching assigned for the ensuing year. Until very recently, the Institute has been able to accept all applications that meet those criteria.

The preliminary proposals, of course, are just that: each will be revised, after consultation with the seminar leader, into a “Final Unit Topic” of about 250 words with initial reading list, then into a “Prospectus” of two to four pages, then into a “First Draft” of about ten single-spaced pages that sets forth the unit’s objectives and strategies, then a “Second Draft” of 15-25 pages that also includes lesson plans and bibliographies, and then a final draft of the “Completed Unit.” This process of writing, which will benefit from suggestions by the seminar leader and the other Fellows, will be carried out concurrently with the common study of a seminar that meets once in March, once in April, and weekly from May through mid-July.

The seminars offered by the Institute—88 of them between 1978 and 1991—have ranged widely in topic and procedure. Some, especially in the sciences, have tended toward a lecture format; others have placed major emphasis upon informal discussion of a series of texts. All have found place for some sharing by the Fellows of their pedagogical interests and problems. And some have also
incorporated field trips, laboratory projects, exercises in theatrical presentation, and additional writing assignments. A bare sampling may serve here as an indication of the range of the seminars and the commitment of Yale faculty to this enterprise.


The Institute’s pervasive concern with writing has sometimes been given special emphasis, as in “Writing Across the Curriculum” (Joseph W. Gordon) and “The Process of Writing” and “Writing About American Culture” (Thomas R. Whitaker). Seminars in art have included “Elements of Architecture” (Kent C. Bloomer), “Art, Artifacts, and Material Culture” and “The Family in Art and Material Culture” (Jules D. Prown), and “America as Myth” (Bryan J. Wolf).

The smaller number of seminars in the sciences and mathematics have nevertheless been quite various. The biological sciences have been represented by “Genetics” (Margretta R. Seashore), “Adolescence/Adolescents’ Health” (Walter Ayan), and “Human Fetal Development” (Maurice J. Mahoney), among others; both biological and physical sciences by a seminar in “Global Environmental Change” (Karl K. Turekian); and the physical sciences by such topics as
"Geology and the Industrial History of Connecticut" (Robert B. Gordon), "Engineering and Science at Work: Coal Combustion and Nuclear Fission as Sources of Electricity" (Charles A. Walker), "Aerodynamics: Its Science, Applications, Recent History, and Impact on Transportation" (Peter P. Wegener), "Electrical Technologies: Light at Nite, Microelectronics, Superconductivity?" (Robert G. Wheeler), and "Crystals in Science and Technology" (Werner P. Wolf). Mathematics has entered significantly into many seminars in the sciences, has been prominent in seminars on statistical approaches to adolescent psychology (William Kessen), and has also been a topic in its own right (in seminars led by Robert Szczarba and Charles E. Rickart).

The curriculum units prepared in conjunction with the seminars have been yet more diverse. The later descriptions of the twelve units included here will point to some of the ways in which Fellows have been able to relate seminar topics to their own teaching needs. Special attention should be called, however, to certain kinds of units that are not adequately represented in this volume because the invited authors did not elect to engage in the further revision that it entailed. Many units, such as Maureen C. Howard's "Steinbeck: Biography as a Tool in Teaching Reading and Writing Skills" or Patricia A. Niece's "Horacio Quiroga: The Poe of Latin America," would fit easily into conventional courses in literature. Another group comprises units, such as Doris A. Vazquez's "La Nueva Canción en Puerto Rico" or Belinda M. Carberry's "The Revolution in Journalism with an Emphasis on the 1960s and 1970s," that deal with some aspect of popular culture. There are also studies of a historical figure, such as Henry A. Rhodes' "Lincoln, the Great Emancipator?," and of the art of some historical period, such as Linda Powell's "Egyptian Tomb Art: Expression of Religious Beliefs."

There are also a good many ways of approaching the sciences, as in Elisabet O. Orville's "Perception and Sense Organs—A Writing Unit for Biology," or Beverly B. Stern's "The Basic Conceptions of Diagnostic Ultrasound," or Margaret M. Loos's "Let There Be Light," or Robert W. Mellette's "Space Shuttle Science"—as well as a number of ingenious approaches to mathematics, such as Michael Conte's "Mathematics in You," Sheryl A. Hershonik's "Lunar Eclipse: Fact and Myth," Joyce Bryant's "Mathematics: Problems on Coal and Energy," and David Howell's "The Statistical Sampler." A small volume, indeed, cannot begin to do justice to the great variety of curriculum units that the Fellows of the Institute have prepared over the years.

It should be clear, however, that most units tend toward the personal in style and the interdisciplinary in scope. That is so for several good reasons. At the elementary and middle-school levels, the teacher's responsibilities are often inter-
disciplinary by definition. At the higher grade-levels, in an inner-city environment with many poorly prepared or poorly motivated students, the teacher may most easily demonstrate the relevance of a subject, arouse interest in it, and pursue its exciting implications in some interdisciplinary context. Those pedagogical necessities are often compounded these days by the fact that many urban teachers have been assigned to subjects for which they have had no adequate college-level training, and must therefore make use of their curriculum units in part as a mode of self-education in a field somewhat new to them. And the personal style? Fellows of the Institute provide massive testimony that their own teaching is most engaging and successful when they are presenting to the class a unit that they have themselves developed.

These points have been highlighted and further developed by Peter Joseph Casarella, in his Institute-sponsored study of the curriculum units prepared from 1979 through 1985. Casarella found that the units are most often presented in a first-person narrative style that offers a synthesis of research and pedagogy. Some units may emphasize research and others pedagogy, but the norm is some integration of the two concerns. Elisabet O. Orville's “Pollination Ecology in the Classroom,” for example, was structured to facilitate the expression of her research on pollination ecology; a relatively small part of the unit was devoted to a distinct teaching purpose. On the other hand, Richard Canalori and Farrell Sandal's “Enthusiasm is All Write” was structured to develop a comprehensive course in writing for sixth grade; the research for the unit was oriented entirely toward pedagogical problems. More characteristic of the bulk of the units prepared in the Institute, however, were those that combined research and pedagogy in some personal synthesis. Casarella found such syntheses in every discipline—for example, in Norine Polio's “An Analysis of The Oxcart by René Marqués, Puerto Rican Playwright,” in D. Jill Savitt's “Sex Roles, Courting and Marriage Among Puerto Rican Teenagers,” and in David Howell's “The Statistical Sampler.” Sometimes the author treated the elements specified by the Institute guidelines (objectives, strategies, and lesson plans) in separate sections unified only by mutual implication and a strong narrative voice. At other times the integration dictated a more complete fusion of those elements in a single coherent essay. It is clear from Casarella's report that, regardless of the format chosen, the main thrust of the Institute work is toward some mediation between research and pedagogy according to the needs of students and the interests and talents of the teachers. The editorial preparation of this volume of selected units, which has entailed the reading of nearly all of the units and attention to comments made by seminar leaders, certainly bears out that conclusion.
Fortunately, the units prepared by the Fellows are not merely "course papers" for a seminar. Designed as teaching materials, they have been read in-process by other Fellows, and they receive local publication in a volume of units produced by each seminar, with distribution to schools throughout New Haven. Sometimes the authors may conduct workshops on their topics at other schools. Colleagues in the same school and at other schools often incorporate part or all of a unit in their own teaching. In subsequent years a unit may be revised by the author, and by others, as the experience of teaching may suggest. Indeed, there is much evidence that a significant revision of curriculum has taken place in the New Haven system by this grass-roots method.

Institute surveys of 1981 and 1985 indicated that the extent of use of these curriculum units, by Institute participants and by other teachers, had more than doubled during that period. In 1985 such units were taught in more than fifteen hundred school classes attended by more than thirty thousand students. A third of all New Haven secondary school teachers, whether or not they had been Fellows, were using these materials. A high proportion of the units prepared since 1978 were remaining in use, and the frequency of use did not depend upon how recently they had been written. Many of the teachers who used the units were in fact using two or more, and nearly half were using three or more. There is also suggestive evidence that the participation in Institute seminars and the writing of units may have helped to sustain an interest in a profession that the American people have not yet decided to recognize according to its true social value. In 1985, despite substantial turn-over of teaching personnel in New Haven, most of those who had taken greatest advantage of the Institute remained teaching in this city.

Summaries, generalizations, and statistics will take us only so far. A more vivid and complex impression of the curriculum development that is being fostered by the Yale-New Haven Teachers Institute can be gained only through an attentive reading of selected instances. Hence this volume. A few introductory comments on the twelve units presented here will help to set the stage for such a reading.

II

The twelve units selected to exemplify the process of curriculum development in the Institute are excellent in various ways, but they should not be read as significantly more original or more thoughtful than many others. Indeed, the task
of selection was complex, difficult, and to some extent determined by factors unrelated to the quality of the units. On the basis of recommendations by seminar leaders, supplemented by the editor’s reading of nearly all the units prepared since 1978, a preliminary list was drawn up of no less than sixty units that clearly deserved national distribution. That list was reduced by the editor, with an eye to appropriate representation of various disciplines and various approaches to unit-writing, to a final list of thirty units. (Most of those eliminated at this point were in subjects that have been prominent in the Institute’s work since its inception: history, literature, and social studies.) Invitations were then issued to twenty-nine authors, one now being deceased, to engage in some minor revisions that might clarify their accounts for readers unacquainted with the New Haven schools, update bibliographies where appropriate, and indicate if possible something about the experience of teaching the unit and its importance in the author’s career. Eleven of the units in this volume constitute the response to that invitation. The twelfth unit, by the Fellow now deceased, is presented as originally written. If time and energy were less severely limited than they are for most of us who teach, we might have been able to present at least five volumes comparable to this one! Indeed, if readers are interested in consulting units in fields or on topics quite different from those included here, they should direct an inquiry to the Institute office.

As it happens, these twelve units suggest much of the usual range of disciplinary and interdisciplinary work in the Institute. Seven units are designed for high school, four for middle schools, and one for elementary school. Eight units are in the humanities and social studies, four in sciences and mathematics. Those proportions are roughly in accord with the emphases in Institute seminars over the years. The most distinctive qualities of these units, however, are quite individual. They are evident in many ways, but above all, perhaps, in the ingenuity and persistence with which the Fellows have met the extremely difficult challenges posed by their teaching situations.

The volume begins appropriately with “Melting Pot Theater: Teaching for Understanding,” a unit by Bill Derry, an Itinerant Arts Teacher in elementary schools. Derry offers a “master plan” for a coordinated effort requiring the contributions of several teachers and resource persons. Using drama as his major tool, he proposes to facilitate the teaching of grades 1-4 about the cultures of Puerto Rico, Russia, and Ghana. Though the unit is unusually ambitious, its integration of subjects and resources is characteristic of much elementary-school teaching. And its approach will be familiar to those acquainted with the work of Dorothy Heathcote and other drama educators. Derry’s unit was pre-
pared in conjunction with the seminar on "Contemporary Drama: Scripts and Performance," led by Thomas R. Whitaker in 1990. Although the reading and performance activities in that seminar centered on plays for adults, the Fellows were mainly elementary and middle-school teachers who developed projects suited to their classroom responsibilities. In effect, the subject of the seminar became "Learning Through Drama."

The four middle-school units cover an interesting gamut of subjects. "Who Do You Think You Are?" was developed by Bill Coden, an English teacher for an arts-magnet middle school, in conjunction with a seminar of 1982 led by Richard H. Brodhead on "Autobiography." Coden uses the challenges of student autobiography as means of addressing the teaching of skills in reading and writing. Through a series of adaptations and extensions, this unit has been central to his later teaching. In 1988 he developed a unit on journal-writing, which also incorporated readings from longer autobiographical works. And in 1990 he developed a unit on Chicano literature that deals with similar themes of memory. Each unit responded to a distinct need, but he is now most comfortable when combining elements from each in his teaching.

Benjamin A. Gorman, a social-studies teacher in a middle school, developed "The Community and You: Learning Your Way Around Fair Haven" in conjunction with a seminar of 1989 led by James T. Fisher on "American Communities, 1880-1980." This unit is intended to help low and middle achievers to become more aware of the ways in which geography and history impinge upon their own lives. The anecdotes, the richly detailed historical information, and the mapping activities are of course specific to Fair Haven, Connecticut, but one can easily imagine a unit of this kind being developed in other communities throughout the nation.

"The Chronicles of the New World, Shakespeare's The Tempest, and E.S.O.L. Instruction," by Norine Polio, a teacher in a Bilingual Department, is a unit of a very different kind. Developed in a seminar of 1986 led by Roberto González-Echevarría on "Writings and Re-Writings of the Discovery and Conquest of America," it uses the reading and interpretation of Shakespeare's play as an occasion for considering, by way of Caliban, the problems of instruction in a second language. This unit clearly aims to instruct other teachers as much as middle-school students. Since developing it, Norine Polio has modified it for use with mainstream humanities and reading classes, and has also used it to culminate a year-long curriculum based on materials from the periods of the Conquest.

The fourth middle-school unit presented here, "Crystals: More Than Meets the Eye," by Lois Van Wagner, is designed for the eighth-grade Earth Science
curriculum. Developed in conjunction with a seminar of 1989 led by Werner P. Wolf on “Crystals in Science and Technology,” this unit brings together a wealth of material on atomic and molecular structure, shapes of crystals, characteristics of minerals, and the uses of crystals in modern technology. Since developing this unit, Lois Van Wagner has adapted it, by amplifying or omitting sections, to meet the needs of students with a range of abilities.

The seven high-school units—two in English, two in history, two in mathematics, and one in biological science—illustrate a variety of strategies for relating school subjects to contexts that may provide additional motivation or insight. “Seascape: Beginning Explorations” was developed by Phyllis Taylor, an English teacher at Sound School, which shapes its curriculum in ways that emphasize the marine life and maritime activities associated with Long Island Sound. The unit was written in conjunction with a history seminar of 1982, “An Unstable World: The West in Decline?”, led by Robin W. Winks. Phyllis Taylor chose to use the theme of ocean exploration to provide interest and continuity for a course that teaches reading, thinking, writing, and speaking to high school freshmen. Because this unit incorporates non-fiction, fiction, and poetry, it constitutes one kind of introduction to literature. Phyllis Taylor died in the summer of 1989—while a participant in Traugott Lawler’s seminar on “Poetry”; her unit is therefore presented here without further revision.

“American Detectives: On TV and in Books,” was developed by Jane K. Marshall in conjunction with a seminar of 1989 on “Detective Fiction: Its Use as Literature and as History,” also led by Robin Winks. This unit is an example of an unusually advanced phase in a Fellow’s work in the Institute. It was prepared as the final chapter of a book that Jane Marshall has written on the basis of several units intended for her course in “Visual Art and Literature.” Previous units had dealt with the study of material culture, the comparison of poetry and photography, and the comparison of film and fiction—all as correlated with a study of social history. This culminating unit brings together instances of popular culture in ways that maintain rigor of analysis, both thematic and technical.

The two units in history provide an opportunity for somewhat closer comparison of strategies. “From Plessy v. Ferguson to Brown v. Board of Education: The Supreme Court Rules on School Desegregation” was developed by Karen Wolff in conjunction with a seminar of 1982 on “The Constitution in American History and American Life,” led by Robert M. Cover. It was originally prepared for the history half of an interdisciplinary course in English and history at the High School in the Community, a magnet school that emphasizes teacher-initiated curriculum. Karen Wolff has since used the unit in teaching a variety of
other subjects—statistics and poll-making, drama in the courtroom, and philosophy as reflected in legal systems throughout history—and she has also expanded it into a larger course on the American legal system. Indeed, this unit was for her the beginning of a major new direction in her teaching career.

"The Constitution, Censorship and the Schools: Tennessee v. John Thomas Scopes" was developed by Peter Neal Herndon in conjunction with a seminar of 1988 on "Courts, Congress and the Constitution" led by Robert A. Burt. This unit was originally intended for a course in United States history, and it has since been used in courses at various levels emphasizing issues in Constitutional law. Where Karen Wolff leads students through a series of legal decisions, Peter Herndon invites them to examine in detail the issues (and the drama) involved in a major trial. In different ways, both units relate their subjects to questions of continuing urgency and provide opportunities for critical thinking and writing.

The two units in mathematics also provide instructive comparisons. Both, in fact, were prepared in conjunction with a seminar of 1990 on "What Makes Airplanes Fly? History, Science and Applications of Aerodynamics" led by Peter P. Wegener. The first unit, "The History of Flight and Some Mathematical Applications," by Hermine Smikle, aims to present mathematical concepts that are not usually taught to students categorized as "low achievers," and to do so by relating them to the history of aeronautics. After its historical overview, the unit uses the topic of navigation to approach a variety of rather complex problems in plane and spherical geometry and graph theory. The second unit, "Ship and Airplane Testing: Physics for High School Mathematics Students," by James Francis Langan, transposes the seminar's theme into the realm of naval architecture. Langan is another teacher at Sound School, and he engages problems in hydrodynamics and model-building by way of the history of our understanding of solid and fluid bodies, gravitation, and the mechanical and mathematical principles that pertain to them. He proposes a context for learning some difficult mathematical concepts, and one that may also eventuate in student projects on the history of naval technology.

The last unit presented here, "Creation, Evolution, and the Human Genome," was developed by Anthony B. Wight in a seminar of 1990 on "Genetics" led by Margretta R. Seashore. Designed for use in an interdisciplinary science and humanities course, taught with a colleague in English, this unit deals with theories and debates and discoveries concerning the origins of life, its evolution, and its chemical basis. It serves as one example of how a teacher may tactfully handle difficult questions of interpretation in a scientific context, and
how a course can lead from the history of science on toward more technical questions concerning molecular biology.

A dozen units, a dozen different ways of bringing to the inner-city classroom a lively concern for a specific and often freshly defined subject-matter, the needs and interests of students, and a humane understanding of our social context. These units will now serve also, we hope, to make clear to readers in other communities and other institutions the vitality of curriculum development that can result from a collaborative program that pays attention to academic subjects, pedagogical challenges, and the process of writing.

*Thomas R. Whitaker*
1

Melting Pot Theater:
Teaching For Cultural Understanding

Bill Derry

In all ways of learning, the more active the learner the better. As far as possible, passivity must be discouraged and overcome. This does not mean more activity on the part of the teacher, but a different kind of activity from that which most teachers now display when they go on the assumption that teaching is transferring the contents of their own minds (or their notes) into the minds of their pupils.!

I am an Itinerant Arts Teacher on the Comprehensive Arts Program. I work with teachers and students in grades Kindergarten through Fifth. I also facilitate a city-wide arts program, placing an artist in each of the 225 K-2 classrooms and providing a performance in each of the 25 elementary schools.

As an Arts Teacher I use Drama as a “teaching tool.” Most often I use Drama in conjunction with Language Arts Performance Objectives. In a typical six-session unit each session has a “theme”: Feelings, Senses, Movement, Make Believe, Listening, Playmaking. The emphasis in each Drama session is on getting students to speak and move within a “real” context. For example a student in a statue expressing anger would be asked, “Why do you feel so angry?,” and might respond with, “I feel angry because my bike was stolen!” The student could replay the response with more feeling in the voice or more appropriate body movements.

Sometimes these beginning drama sessions lead to activities which are related to the content being taught by the teacher. (“The Community,” “Regions of the World,” “Seasons,” and “The History of New Haven” are a few examples of different areas of the curriculum taught through Drama.) This unit is designed to work with the school system’s Performance Objectives. It has a flexible structure designed to be adaptable to teachers’ styles and overall school objectives.

The title of this curriculum unit contains the phrase “Melting Pot Theater.” This phrase refers to the creation of a performance through the integration of
many subject areas (including Language Arts, Social Studies, Music, Visual Arts, and Drama) with many resources (school and community artists and arts teachers, guest speakers, audio-visual aids, computer programs, literature on Drama and the cultures selected for study). The primary purpose of this unit is to integrate (melt together) many curricular areas with many resources into a student performance.

The other purpose of this unit is to address the issue of multiculturalism in America, and how much children should learn about minority cultures. An insightful article in the Village Voice entitled, "Whose America is This, Anyway?" discusses a 1990 New York city report calling for a "curriculum of inclusion." The report states that "the multicultural approach is seen as serving the interests of all children from all cultures: children from [minority] cultures will have higher self-esteem and self-respect, while children from European cultures will have a less arrogant perspective of being part of the group that has 'done it all.'" This article provides negative and positive criticism from writers of six major U.S. newspapers and the President of the American Federation of Teachers.

New Haven has many different cultural groups and much is presently done in some schools to promote student awareness of cultural differences and similarities. I think that the more experience a student has with different customs and points of view, the more flexible he or she will be when confronted with differing opinions, attitudes and customs. Whether a school system is made up of a variety of minority groups or not, the United States is a multicultural society. America is based on principles which take into account peoples' different points of view. A Eurocentric curriculum does not always accurately teach an understanding of the values of cultural diversity and common history.

Although this unit stresses the melting together of various disciplines, it is not designed to melt the cultures together into one culture. It is intended that each culture will be studied and valued for its unique and individual characteristics—and that what will be stressed is the importance of each culture maintaining these characteristics while sharing some common traits.

I have chosen three cultures to study: Puerto Rico, Russia, U.S.S.R.; and Ghana, Africa. Since many of our students in New Haven are from, or have parents from, Puerto Rico, it was a natural choice. Most children do not even realize that Puerto Ricans are not foreigners! I chose Russia for many reasons. Until recently Russia was rarely available for in-depth study. The word "Russia" evoked fear and blank images. Many people, including myself, have visited the Soviet Union and found a different reality than expected. Russia, although one republic of the U.S.S.R., has problems of its own in coming to terms with the one hundred ethnic groups found in the Soviet Union. Between 1820 and 1987
nearly 3.5 million people have immigrated from the U.S.S.R., providing the 6th largest percentage of total U.S. immigrants.\(^4\) Ghana was chosen for many reasons as well. The majority of our students are Afro-Americans, many of whom can trace their heritage back to West Africa. There are also local artists and teachers in New Haven from Ghana who could be hired to work with students. The unit will provide more opportunities to focus on the many contributions of Afro-Americans.

**PROPOSED AUDIENCE AND TIME FRAME FOR UNIT**

This curriculum unit has been developed for students in grades 1-4 in a new elementary magnet school, The Language Academy. The school will provide foreign language instruction and multi-cultural experiences. The unit will be implemented over eight weeks in seven classrooms: two First Grades, two Second Grades, two Third Grades and one Fourth Grade. This curriculum unit is not designed specifically for the Drama teacher, but is designed for use by a teacher with some experience in the use of Drama who is in a "support" position, i.e., a Curriculum/Staff Developer, a Visual Arts teacher, a Music teacher, a Library/Media Specialist, etc. The person who implements this unit must have an overall picture of the whole project and be willing to coordinate all who are involved. This person will be akin to the Producer of a production, although s/he must be prepared to direct a great deal. The person in charge must select classroom teachers based solely on their desire and commitment to be in the project. The Project Leader or Producer will try to get the teachers to have as much input as possible, but must be prepared to provide ideas, resources and support.

**OBJECTIVES**

This unit will *not* include as a purpose or objective, "to learn about theater"—but will emphasize the use of Drama as an educational tool. I am most interested in Drama as context, as the medium within which learning can take place. This context can be applied to an infinite variety of contents. The content I have chosen for this unit is multiculturalism. I think that Drama is a particularly good tool to use when teaching multiculturalism, since it allows students to learn through action and experience.

After students have completed this unit they will be able to:
1. Define culture. "The culture of a particular group is its total way of life. It includes all the things the group as a whole thinks, believes, and does. To study a group’s culture is to study its art, literature, religion, philosophy, sports, clothing, politics, customs, and habits. We may speak of the culture of a country (American culture), the culture of a region of the world (Southeast Asian Culture), or the culture of a racial group (black culture). A culture that is especially large and complex is called a civilization."^5

2. Identify at least three cultures which have helped to make up the U.S.A.

3. Count from one to ten in each of the following languages: Spanish, the language of Puerto Rico (U-no, DOS, TRES, CUAT-tro, CIN-C-o, SEIS, si-ET-e, O-cho, nu-EV-e, di-EZ); Tswi, a language of one group of people in Ghana (o-HUN, BAA-ko, MI-enu, Mi-EN-sa, E-NAN, E-num, N-sia, N-son, nMOU-cha, Nk-RON, E-du); Russian, the official language of the U.S.S.R. (ah-DEEN, dvah, tree, chih-TEE-reh, pyah, shayst, seeaym, VOH-seeaym, DYEH-veht, DYEH-seht).

4. Locate on a map the continents of North America, Europe, Asia, Africa, and South America.

5. Locate on a map the U.S.A., Puerto Rico, the U.S.S.R. and the republic of Russia, and Ghana in West Africa.

6. Tell at least two folk tales, each from a different culture.

7. Sing at least two songs from two different cultures.

8. Name at least 2 natural resources from each culture studied.

9. Identify traditional folk music of Puerto Rico, Russia, and Ghana.

10. Draw three different scenes which could each be identified as being one of the cultures studied.

11. Take part in a performance which will focus on some aspects of life in Russia, Puerto Rico, and Ghana.


STRATEGIES

First, the coordinating teacher must determine the players. In this unit the following key people are assumed to be included: the coordinator (in this case, played by myself—as Itinerant Arts teacher in Drama), the Music teacher, the Physical Education teacher, seven classroom teachers and their students. The idea should be presented at a staff meeting to consult with every teacher and the principal. Each player should make a verbal and written commitment to the project.
Second, define the roles of each player. Some of the definitions will be based upon individual teachers' strengths and weaknesses. In my model I am assuming, for example, that the Physical Education teacher has experience in dance. I am also assuming that each classroom teacher is willing and able to carry out Visual Arts activities with her students. Visual Arts consultants from the Comprehensive Arts Program would probably be available for assistance in designing lessons, if help is needed.

Each teacher will choose one of the three cultures (Puerto Rico, Ghana, or Russia). The fourth grade class will become specialists from an “alien” culture who study other cultures: Anthropologists, Scientists, Psychologists, Historians, Language Specialists, Economists, etc. This improvisational Drama in Education technique, called “Mantle of the Expert”, was developed by Dorothy Heathcote. It allows students to assume an expert role within which to work in a drama.⁶ They will eventually interact with the six other classes and help to create the necessary tension in the final production.

For eight weeks each class will be immersed in the study of the chosen culture or dramatic mode. The Music teacher will teach songs of each culture; the Physical Education teacher will teach a dance from each culture; the classroom teachers will determine content and prepare whole group, small group, and individual instruction for their students; the classroom teacher will be responsible for all costumes and scenery for their class’ dramatized section; the Drama teacher will work with each group on creating a play which fits into a “story” that all seven classes will produce, will consult with teachers and assist with costume and scenery ideas, and will bring in several specialists to work with the teachers and their students.

Third, determine the content to be taught. Using the resources presented in this unit, as well as other resources with which the teachers are familiar, each teacher must determine the song, the folk tale, the natural resources, etc. of the culture being taught. The chart, Areas of Culture and Content, included with this unit should be helpful.

Fourth, determine the specific activities to be performed in each group. A master-schedule should be created by all participating teachers charting the activities and dates for the project. (See the Sample Master Schedule in this unit.) Activities should be identified as whole group, small group, or individual instruction. Existing filmstrips, video tapes, recordings, 16mm films and other audiovisual aids will be identified that are presently in the New Haven Public Schools. (See Bibliography) The project participants will determine to which of three instructional categories these resources best lend themselves. When
group decisions become difficult, the coordinator should come to a decision and consult the entire group for feedback, changes or agreement.

Whole group instruction will be used for background information on each culture—teaching the students to count from 1-10 in the language of the culture they are studying, teaching songs, telling folk tales, and teaching a dance. Each group will watch a video and/or filmstrip on the culture they are studying. Drama activities will be conducted with every class. Each group will begin this curriculum unit by creating a culture of its own. Students will use a dramatic mode to set up a “typical” shop or marketplace for each culture. They will make their own “play” money in the correct currency of the culture, and use it to purchase goods.

Rehearsals for the play will take place in each classroom, but will move to a large space, where each group will have a part to play in the final production. The Coordinator/Drama teacher will focus on the kind of drama done by Dorothy Heathcote in which teachers are guided to find material, select symbols, achieve dramatic focus, heighten tension, and slow pace to lead children to significant moments of insight. The group which creates the “alien” roles will serve as the storytellers in the final performance. (See the Sample Lesson Plans, Sample Script and Bibliography for assistance on these projects.)

The final performance will be done for other students, teachers and their parents. This will help solidify the information learned and provide students with the experience of teaching through performance. It will also serve to bring the school and community together and create a greater sense of individual pride and a larger sense of school pride.

Small group instruction will take place with projects such as flag making, papier mâché map making, and scenery building. Small groups will work on recipes to create foods from the cultures being studied. Parents will be requested to assist with this part of the project.

Individual instruction will occur for remediation and enrichment, and for help on individual projects that students will create. Cassettes or records with music from the culture(s) being studied will be made available for individual listening. Although students will learn to count in large groups, they will be able to practice by themselves with cassette tapes and headphones. Students can listen to their classroom teacher counting from 1-10 in the language of the culture they are studying. A small library of books, maps, and pamphlets will be collected for individual student perusal.

Fifth, meet regularly to evaluate. The Coordinator/Drama teacher and the participating teachers need to meet at least one time every two weeks, to check progress, share notes on the direction of the production and change
direction if necessary. These meetings should be included on the master schedule.

SOME DRAMA IN EDUCATION TECHNIQUES

The most important single factor in the use of drama as a genuine part of education is the teacher. It would be preposterous to pretend that a teacher needs no preparation for doing drama—but it is equally preposterous to suggest that a teacher who sees the values of using drama needs a course in theater.8

The aim is constant: to develop people, not drama. By pursuing the former, the latter may also be achieved; by pursuing the latter, the former can be totally neglected, if not nullified.9

Games provide one of the easiest entry points into the world of Drama in Education. Drama games come with rules and boundaries built into them. Viola Spolin, Nellie McCaslin, Geraldine Siks, and Brian Way offer many games which can be used to promote concentration, involve creative movement of the body, improve language skills, and promote groups working together. The game for this unit involves identifying feelings, which are found in people of all cultures. (See Sample Lesson 1)

Creative Drama involves the use of the body and voice in authentic responses to sounds, stories, words, images and/or ideas. The teacher provides stimuli through storytelling, games and a variety of drama techniques described in this section. The process is more important than the product, although the product may be shared with an audience. Creative Drama addresses individual and group creative expression and is particularly useful for getting students working together. When applied to a curriculum area it is often referred to as Integrated Drama. (See Sample Lesson 2)

Dance focuses on the movement education of the body. Often a teacher need only be shown dance steps by an “expert” to teach the dance to his or her students. Pantomime would be included as a component of dance. Understanding non-verbal signals or body language is particularly important when verbal communication is not possible, as is true with people who do not understand each other’s language. Dances from other cultures often serve as a bridge to communication. (See Sample Lesson 3)

The use of a person in role is a powerful teaching tool. The teacher, a visitor or a student(s) can assume the role of a person or group, taking on a specific attitude or set of information. An example in this unit is a man from Ghana, acting as tribal chief or a member of the Ashanti tribe, his attitude being: “The mod-
ernization of Ghana is causing the ruin of our people.” Students are confronted with a “real” person to question, and are forced to use feeling and thought. Assuming a role is a common technique used in the teaching of Dorothy Heathcote. (See Sample Lesson 4)

Improvisation is the spontaneous acting out of a situation, often including language. Viola Spolin has been a leading advocate of this method of drama and has several good books for teachers, actors and directors. In this unit students will use a form of improvisation to create a culture of their own. This will give them a foundation from which to view other “real” cultures. (See Sample Lesson 5)

There are several units created by previous members of the Yale–New Haven Teachers Institute which provide many drama activities for classroom teachers. The problem is not in finding the activities, but rather in finding the merit in using them. If a teacher sees the merit in the use of Drama, he or she will seek out the “experts” who are listed in this bibliography and the bibliographies of many other such units. This curriculum unit assumes the teacher using it is willing to start from where they are and work towards creating more literate students—not towards creating student actors.

THE IDEA OF DRAMA AS CONTEXT

I have already stated the fact that Drama in this unit will be used as context. It needs further explaining, if this unit is to be implemented. Although I am suggesting some of the content to be taught, I am not concerned about the many facts which could be taught. I trust that the books and resources listed in the bibliographies and the abilities of the teachers involved in this project will provide more than enough content. The following quote is from the “Bible” of the Foreign Language Department:

Many teachers are afraid to teach culture because they fear that they don’t know enough about it. Seelye (1984) maintains that even if teachers’ own knowledge is quite limited, their proper role is not to impart facts, but to help students attain the skills that are necessary to make sense out of the facts they themselves discover in their study of the target culture. He points out that the objectives that are to be achieved in cross-cultural understanding involve processes rather than facts. Facts are cheap. They are also meaningless until interpreted within a problem-solving context.

The context which will be created to hold some of the content taught in this unit will be the “script” used for the culminating activity—the performance. The script will be “better” if it includes a plot, tension, characters, and a climax. As
described in the “Master Schedule,” the script is created by the group working on the project. If the class studying Puerto Rico focuses on the bizarre Festival of the Masks, an annual island festival, then they, with the help of their teacher, could create a short scene where a family is preparing for the event.

In order to provide a concrete example of what I mean I have created a “Sample Script” which has spaces that must be filled by specific classes. The script could be used as a starting point for the project or thrown out entirely in favor of a different set of characters and situations. This script is not complete! The tension in the script will be created from the juxtaposition of very different cultures: the alien culture, created by the fourth grade, and the three cultures being studied by the other six classes: Puerto Rico, Russia and Ghana. (Following are a “Sample Content Chart,” a “Sample Script,” a “Sample Master Schedule,” and five “Sample Lesson Plans.”)

**Table: Areas of Culture and Content**

<table>
<thead>
<tr>
<th></th>
<th>Ghana</th>
<th>Puerto Rico</th>
<th>Russia, U.S.S.R.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Continent(s)</strong></td>
<td>Africa</td>
<td>In the Caribbean, off North America</td>
<td>Europe/Asia</td>
</tr>
<tr>
<td><strong>Capital</strong></td>
<td>Accra</td>
<td>San Juan</td>
<td>Moscow</td>
</tr>
<tr>
<td><strong>The Land</strong></td>
<td>Coast, forest, grasslands, smaller than Oregon</td>
<td>Island, about the size of Connecticut</td>
<td>Tundra, forest, grassland, mountains, desert; VERY LARGE</td>
</tr>
<tr>
<td><strong>The Climate</strong></td>
<td>Rainy, dry</td>
<td>Tropical</td>
<td>Tundra-cold, four seasons, varied climes</td>
</tr>
<tr>
<td><strong>Language(s)</strong></td>
<td>English, Twi, Moshi-DagombaGa</td>
<td>Spanish, English</td>
<td>Russian</td>
</tr>
<tr>
<td><strong>Foods</strong></td>
<td>Cassava, fish, manioc, banana, rice, corn, sweet potato, peanuts</td>
<td>Rice, beans, plantain, pineapple, pigs, cattle, chicken, fish</td>
<td>Potato, bread, cabbage, beets, cucumber, chicken, beef</td>
</tr>
<tr>
<td><strong>Monetary Unit</strong></td>
<td>Cedi</td>
<td>U.S. Dollar</td>
<td>Ruble</td>
</tr>
<tr>
<td><strong>Work</strong></td>
<td>Subsistence farming, mining, fishing, manufacturing</td>
<td>Government, farming, trade, tourism, fishing; manufacturing</td>
<td>Construction, engineering, farming, fishing, manufacturing</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>Description</td>
<td>Description</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Travel</td>
<td>Boat, truck, car plane, Car, bus, plane, boat</td>
<td>Metro, car, bus, trolley, truck, boat</td>
<td></td>
</tr>
<tr>
<td>Shelter</td>
<td>Apartments, concrete with iron roofs or mud with grass roofs, Apartments, houses, some palm thatched huts</td>
<td>Small concrete apartments in large housing complexes, wood house, possible thatched roof</td>
<td></td>
</tr>
<tr>
<td>Leisure</td>
<td>Theater, movies, Warri, sticks, soccer, dancing</td>
<td>Theater, ballet, symphony, sports, cockfighting, movies, TV</td>
<td>Theater, ballet, dance, chess, sports, sledding, TV, circus</td>
</tr>
<tr>
<td>Law</td>
<td>Police, courts</td>
<td>Police, courts</td>
<td>Police, courts</td>
</tr>
<tr>
<td>Health</td>
<td>Many diseases, limited health care</td>
<td>Private health care</td>
<td>Government health care</td>
</tr>
<tr>
<td>Education</td>
<td>Public and Mission schools, uniforms, universities</td>
<td>Public schools, universities, religious education, uniforms</td>
<td>Public schools, uniforms, 1-12, job training, special universities</td>
</tr>
<tr>
<td>Clothing</td>
<td>Shirt &amp; shorts, African, European, toga (kente), dresses</td>
<td>European, Latin, American</td>
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<td>Catholic, Protestant, Spiritualism, Pentecost</td>
<td>Atheist, Russian Orthodox, Muslim</td>
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<td>Extended village tribal</td>
<td>Extended European/Latin American</td>
<td>European, Nuclear-sometimes extended</td>
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<td>Sugar cane, yams, coffee, bananas, copper, nickel</td>
<td>Coal, oil, metals, wood, manufactured goods, agricultural goods, natural gas</td>
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Table: Areas of Culture and Content (continued)

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<th>Commonwealth associated with U.S.</th>
<th>Socialist republic, 1 party system--Communist, changing</th>
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<td>European, classical, modern, jazz</td>
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<td>African/Latin influence, masks, theater, dance</td>
<td>Dance, theater, new &quot;social realism&quot;</td>
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<td>(Examples)</td>
<td>Ananse</td>
<td>Juan Bobo</td>
<td>Baba Yaga</td>
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SAMPLE SCRIPT: "WHEN CULTURES COLLIDE"

Time: The Present

Plot Synopsis  Action begins on an Alien Space/Time Ship. The ship runs out of fuel. Three groups of aliens head off to Earth in three small exploratory vessels in search of fuel. Each group is lead by a high-ranking alien official. One group goes to Puerto Rico, another to Russia, and the third to Ghana. They are able to learn languages quickly, but they do not fully comprehend everything they see and hear. They become intrigued by the people and ask questions. They share stories, songs, dances and other customs. The leader of the aliens can meet the leader of each culture. Each group collects the energy from emotions released by the people they visit in their fuel collectors. (This idea is based on the thought that feelings and emotions are something that is shared by every culture, regardless of differences—I would discuss this with students, and see if they had an idea they liked better.) As the aliens collect emotion they also begin to speak with more emotion.

Characters  (Only a sampling of some of the possible characters. It is best not to get bogged down with long segments of drama with only a few characters interacting. The play is built around group scenes.)


(All Alien characters must speak without emotion!)

Aztecala: How much further can we go, Captain?

Captain: Queen Aztecala, the fuel is almost empty! We must refuel.

Time Expert: I am the time expert and I know that we have 31 seconds of fuel remaining!

Space Expert: I am the space expert and I know that we can travel another 1 million miles in 31 seconds!

Aztecala: What can we do, oh Pozxter the Wise?

Pozxter: My built-in computer shows that we can find fuel on that planet. (Points outside spaceship. A slide of Earth can be projected on a screen for the audience to see.) It is called Earth by the people who live there. We will have to search for fuel.

Leader 1: Remember we must not harm one thing or we will lose our space driver's license.

Leader 2: Even though we will be invisible, if our power goes, we will become visible. We must look like these earthlings if we are to not frighten them.

Leader 3: Pozxter, can you get us some pictures of these earthlings on our screen?
Leader 1: Lucky that we saw them in advance. They are very scary.

Aztecala: Scientists—please make us look like the Earthlings.

Scientist 1: Are you sure you want to do this?

Artist: Maybe it is better to run out of fuel!

Pozxter: There!! (Pozxter lifts his arms; special sound effects; most of the students take off “ugly” alien masks and costumes—they are transformed into Earthlings. They continue to wear something which identifies them as “aliens”, i.e., green pointed hats, silver shirts, big red dots on the back of their costumes, etc.) Remember with those “hats” on you will not be visible. You will go to different places on the planet. Gather as much information as you can while you are there.

Book Writer: Oh yes! I will write a book on this planet Earth.

Captain: We will take three small ships and travel to . . .

Pozxter: Just make sure you stay on land. Much of this planet is covered with water—and you know how dangerous that is for us!

Food Grower: My great grandmother said her sister fell into a pond on a purple planet! She just disappeared! I would never touch water.

Aztecala: Of course no one would be stupid enough to touch water! Let’s go! (The issue of not touching water is filled with tension and could be developed to heighten dramatic tension.)

Pozxter: Everyone! Pick up a fuel collector on your way onto the ship. Keep your fuel collector on at all times! When they are full return to the ship!

Narrator: (Can be one person at a microphone, a small group, or entire class doing choral speaking.) The three groups of aliens traveled in their small ships to three different places on the planet Earth. One group landed in a small town on the island of Puerto Rico in the Caribbean. Another group landed in the outskirts of Moscow in Russia. The third group landed in Ghana in a small village near the city of Tamale. Let us go to Africa and find out how this group is doing. (During this talk, slides of maps are projected on the screen so the audience can see where the space ships land. If a camera is available students or teachers can make the slides, using slide film, and maps from books or the large maps usually found in classrooms.)
(The aliens have landed outside an elementary school in Ghana. All students are in school uniforms and the teacher is teaching the class in English, the official language of Ghana.)

**Leader 1:** Look! They are all wearing the same costumes, like us!

**Leader 2:** Our clothes are not costumes!

**Teacher:** One group has created a play based on the Ananse story, *Why Spiders Live in Dark Corners*. Now we will watch them act it out.

**Grade One:** Dramatize Ananse story. (See Lesson Plan #1 for this project.)

**Alien 1:** That will be a good one to tell back on the ship.

**Alien 2:** Who would have thought that was the reason why spiders live in dark corners.

**Alien 3:** That Ananse Spider is a real trickster.

**Leader 1:** Look at our fuel collectors. We collected a lot of fuel already. Look over there.

**Alien 1:** It looks like they are exchanging goods. Listen! Sounds like a good place to bring our fuel collectors!

**Grade Two:** Dramatize market scene. (Improvise—See Drama Bibliography)

**Narrator:** The aliens filled their fuel collectors and made their way back to their space ship. Let us go to the group in Russia.

**Grade Three:** Dance the Troika. (See Lesson Plan #3)

**Grade Two:** Dramatize story of Baba Yaga. (See Lesson Plan #1)

**Narrator:** The aliens filled their fuel collectors and made their way back to their space ship. Let us go to the group in Puerto Rico.

**Grade Three:** Sing a Puerto Rican song like “Coqui” (The Little Frog). (Contact Kay Hill at Bilingual/Foreign Language Department)

**Grade One:** Dramatize a Juan Bobo story. (See Lesson Plan #1)

**Narrator:** The aliens filled their fuel collectors and made their way back to their space ship. Let us return now to the Alien’s ship.

**Azteca:** We’ve done it! We have collected feelings from the people on Earth and have enough fuel for another billion megacenturies!
SAMPLE MASTER SCHEDULE

This schedule has been created for an elementary school which has music, art and physical education teachers willing to work on this project. The production will serve as a culminating event for the full teaching unit, and also as a culminating event for the end of the school year. Obviously the unit can be used at the time of year best suited to the participants, although it is planned that this unit will be implemented between September 1, 1990 and June 10, 1991. In a situation where the coordinator does not feel able to do the drama, it is hoped that the teachers will be prepared to do as much of it as possible, and if necessary, an “expert” can be brought in as a consultant.

September: The Coordinator presents the project to the entire staff at a staff meeting. Special effort must be made to involve ancillary staff (Art, Music, Physical Education), as they may not come to staff meetings. This meeting is held to identify teachers, begin the process of collecting resources and to gain early commitment. If the entire staff is involved, meetings should always be held at a regular staff meeting to involve the Principal or school facilitator. The “tentative” unit dates are given: April 1–May 31. The “tentative” performance dates are given: June 3—whole group rehearsal, June 4—Dress Rehearsal, June 5—1:00 p.m. afternoon performance and a 6:30 p.m. evening performance. Effort should be made for staff to check all other schedules to determine if these dates conflict with any other school or classroom functions. Dates will be confirmed at the October staff meeting.

October, November, December, January, February: Updates given at regular staff meetings. At the October meeting the dates for the Unit and Performances are confirmed. Resources for the study of the three cultures are continuously being identified. (See Bibliography) Methods for involving parents in the project are discussed. (Individual letters home with students, P.T.O., the School Newsletter, etc.) Coordinator talks with individual teachers to get ideas and hear concerns. Teachers understand that they will be responsible for parts of the production—not the entire thing.

Each room will work on their part(s) and only during the whole group rehearsal will everyone come together. This process allows the least amount of “disruption” to normal classroom routine, and allows the maximum number of students to benefit from performance. In January and February a separate date after school is set aside for all interested teachers to work on the script for the play. Room must be left for students to have input. Their ideas in the play will give them ownership! The sample script should serve as a guide—not as the final product!
March 5: Update at staff meeting. Have all resources been identified? Have artists been contacted? If payment is necessary, has a funding source been identified or created? Is each participant comfortable with the direction and accomplishments to date? Although there will be ongoing updates at future staff meetings, separate meetings will now be held to address all of the needs and issues of this project.

March 27: (45 minute meeting.) The entire schedule will be given to each participant for feedback. Discuss problems, resources, parent input, programs, video-taping, the sale of goods at the performance (possibly foods from the studied cultures), special invitations. An outline of the script is presented.

Eight Weeks Of Lessons (April 1–May 31): During the first week, introduce project to all students. Explain that each class will study a specific culture for eight weeks, and the study will culminate in a performance. The following teachers (listed alphabetically) will assume the roles listed:

Art Teacher: Assist with costume ideas, lead costume making workshops for teachers and/or students, assist with prop and scenery ideas, lead groups of students and/or teachers in the creation of props and scenery. (The idea of a teacher workshop would be for teachers to learn how to lead the activity with their students.) Mask making, interior of space ship, three environmental murals: Puerto Rico, Russia, Ghana. Create Adinkra cloth, common in Ghana. Make stamps of common symbols found in Ghana. (Chart available at Yale's Department of African Studies.) Possibly lead students who are playing the aliens in the creation of “new” instruments for their culture.

Classroom Teacher: Find and create resources, teach content (see chart), teach 1-10 in the language of the culture (make an audio tape for students to listen to on their own), show audiovisuals, rehearse scene(s) to be performed, involve parents.

Coordinator: Update script as it is changed; make copies of scripts for teachers; communicate with teachers, parents and principal; bring in visiting artists and find as many resources as possible; support teachers to make the project as positive as possible. (Remind teachers that the project should not be a “pull out” project, i.e. individual students will not be taken from classrooms for rehearsal. It is designed as a puzzle, all the students in each classroom being a self-contained puzzle piece which fits neatly into the whole picture.)

Drama Teacher: Do at least eight Drama sessions with each class: Lead Games to assist students with basic drama skills (See Sample Lesson 1); two sessions each to tell stories to students from each culture using Creative Drama to lead them towards the creation of a play (See Sample Lesson 2); one or two ses-
sions on leading dance/movement instruction with each class (See Sample Lesson 3); lead fourth grade towards the creation of an alien culture (See Sample Lesson 5); one Drama session for each 1st, 2nd and 3rd grade on the creation of a new culture (See Sample Lesson 5); two sessions to develop a family scene and a market scene from each culture (See Sample Lesson 5); one session to go over the scene which will be presented in the final production. Extra sessions at discretion of teachers.

Music Teacher: Teach each class at least one song from the culture the students are studying. Expose students to music of each culture. (Music from Ghana available at Yale African Studies Center; Music from Puerto Rico available from the Bilingual/Foreign Language Department; Prokofiev's Peter and the Wolf can be used as one example of music composed in Russia.) Create a new piece of music to play with the fourth grade alien culture. (They will have to make their own "new" instruments—possibly done by the Art or classroom teacher.)

Parents: Advertise, assist with costumes, help create large pieces of scenery, two or three parents needed to assist classroom teachers with students in their classrooms the evening of the performance, video tape the production.

Physical Education Teacher: (Go over three dances that have been taught to students in six classes.) If the P.E. teacher has a dance background, s/he can take the dance teaching responsibilities. Assist fourth grade with the creation of their own dance. Possibly teach games more common in other countries: soccer, cricket, etc.

Principal: Notify parents of performances, arrange for schedule changes necessary in lunch, have chairs set up, announce the program at both performances.

Visiting Artist: Demonstrate customs of one or more of the cultures studied.

REHEARSAL/PERFORMANCE SCHEDULE

June 3: Rehearse for the first time from 9:00-11:00 a.m. the whole performance piece. This is the only time all the classes get to see the whole play. Video tape.

June 4: Dress Rehearsal 1:00-2:00 p.m. (The Production should be kept to a one hour maximum.) Video tape.

June 5: Two Performances: 1:00 p.m. and 6:30 p.m. Students use their classrooms as dressing rooms and return there when their performance is over. Video tape.
ACTUAL PROJECT IMPLEMENTATION

This project was written with the idea that it would be implemented at a newly opened magnet school in New Haven called the Clinton Avenue Language Academy. The school focuses on multicultural activities and teaches Spanish to all students in the program. Implementation at that school was not possible, however.

This unit was proposed to the 17 teachers at Davis Elementary School in February, 1991. Teachers liked the idea, and are presently reviewing the unit for use between April and June. Teachers have the option of adding a culture that they are presently studying. Mexico and Israel have already been added to the unit. The Physical Education teacher, Art Teacher and Music Teacher will be involved. Since the project started much later than anticipated, each classroom teacher will determine the “depth of study” based on his or her resources and time. Two important goals will still be achieved: to expose students to different cultures and to promote positive school-community relations.

For more information on the outcome of this unit and further enhancements, changes and implementations, or if you have implemented the unit and would like to share your changes and feedback, you can contact me: Bill Derry, Comprehensive Arts Program, Gateway Center, 54 Meadow Street, New Haven, CT 06519.

A special thanks to Professor Tom Whitaker, who lead our Yale-New Haven Teachers Institute seminar, entitled “Contemporary American Drama: Scripts and Performance.” He provided rich experiences in improvisation and helped us analyze characters and scenes from several plays. He was instrumental in shaping the final form of this unit.

SAMPLE LESSON PLAN #1

Drama Mode

Game (By virtue of the fact that the teacher sets the rules, and there are specific boundaries.)

Purpose

To know the words of at least six feelings.
To experience the relationship between feelings and body movements.
To experience the relationship between feelings and use of words.
To read body language.
To introduce feelings, since they are an integral part of the final production.
The aliens’ fuel is “feelings.”

**Activities**

Students pretend to wear masks. The teacher asks them to put on a mask which shows no feeling. (The robot mask.) The teacher explains that as humans this is impossible, but with drama we can “make believe” or act “as if” it is real.

Have students hold their hands down on their desks. It is important that feelings be isolated on the face for the first part of this activity. It is difficult not to let feelings into all of our body.

With no talking put on a happy, sad, angry, and frightened mask. After these four masks, ask students for feelings that have not been done. Help them if they do not respond. Other feelings might be: greed, surprise, pride, jealousy, etc. Only do two or three more.

Next, talk to students about the use of the voice to express feelings. The teacher reads a selection from a reading text with no feeling, then with anger, and sadness, etc. Students will quickly understand that feeling changes the meaning of words.

The teacher now repeats the first exercise, but says “hello” to the students with the feeling expressed by the mask. Students echo the word “hello,” mimicking the teacher’s style.

The students now stand in a space near their desks. The teacher explains that they will now “isolate” feeling in another part of their bodies. This time instead of the face, they will use their hands. When the teacher says a feeling, the class has a count of three to make their hands show the feeling. Each student must take the feeling off their face. The teacher points out different qualities of the hands which express the feeling, i.e., anger: tight, angular; sadness: light, rounded, etc.

The next activity involves the students making a statue with their bodies of the feeling. Each student should try to show the feeling all over their bodies.

The final step is for students to think of a reason for their feeling. The teacher goes around and asks different students, “Why do you feel so . . . ,” and the student responds with a reason. Each student’s movements and quality of voice should be appropriate to the named feeling.

In order to make this sequence of events more obviously game-like, the activity concludes with a “real” game, “What’s My Feeling?” Three or four students create a feeling statue in front of the entire group. They must come to life and
express their feelings for at least 30 seconds, using no sounds. Students can
guess what the feeling is. The second stage of the game would be to guess the
situation. The students in front of the class would complete the game by acting
out the situation (with words) for the rest of the group to see how close the guess
was to the actual situation.

SAMPLE LESSON PLAN #2

Drama Modes

*Storytelling/Creative Drama/Playmaking:* Students use a variety of drama
techniques to play out the story told by the teacher. Through repetition the play-
ing out becomes a play and the story can move towards production.

Purpose

To know the story *Why Spiders Live in Dark Corners*, an Ananse story from
Ghana.

To participate in a group telling of a story.

Activities

The teacher tells the story, *Why Spiders Live in Dark Corners*. Select
characters for acting the story out: Ananse, Mrs. Spider, Two Magicians,
Sticky Scarecrow, and Spider Children (all the children left are the spider
children). The teacher acts as narrator, and fills in where the students need help.
This depends on the skill of the students and the quality of the original story
telling. The teacher plays a spider child! Establish spider movement by demon-
strating a possible spider movement to the class.

The spider children are all squished together. The teacher leads the group in
complaining about the small rooms. Mother says she will go and ask father if
they can move into a new house. Mother tries to wake Ananse three times,
"Ananse ... Ananse ... Ananse!!" Ananse wakes and says, "What dear?" She
asks her question and he replies: "Oh, my back hurts! Oh, my head hurts! Oh,
my stomach hurts! You will have to do it yourself!"

The teacher leads *in role* as a spider child; moving furniture together, build-
ing walls and creating a new house. Mother may need a reminder that the gar-
den has to be built. After Ananse gives his pat response, the children plant all
kinds of vegetables: peanuts, rice, cassava, yams, beans, etc. They mime water-
ing it with water cans and the narrator (teacher shifts roles from spider child to story mover) says: “The garden grew and grew and grew. Finally the family made a giant feast.”

Family mimes preparing feast. Ananse is asked to join. He leaps in the air and runs to the table. The children and Mrs. Spider all go to sleep before he finishes. He thinks to himself, “Oh, if only I could eat and sleep forever. I would be the happiest spider alive.” Ananse gets the idea to go to the magicians, and the magicians tell him what to do when he gets home. They give him a magic root which when eaten makes one appear dead. Ananse is to tell his family he is so sick he is going to die. The family should dig a hole for him in the middle of the garden and put his fork, knife, spoon, plate, cooking pot and bed in it. Ananse should take a bite from the root and “die.” After the funeral, dirt should not be placed in the hole, but banana leaves should be placed on top so Ananse will have a little house in his afterlife!

Children and Mrs. Spider cry when they hear Ananse is going to die. (This can get too silly. Stop it before it goes too far. Ask students to make it as real as possible.) Make a circle and pretend to dig a hole. Mother asks children to bring in the fork, knife, plate, spoon, cooking pot and bed. (Teacher guides Ananse to lie down after eating the magic root.) Teacher, as the oldest spider child, chooses four or five students to help carry Ananse into the hole. (Good trust activity which can be done seriously by First Graders!) Teacher leads students in reminiscing about father: i.e., “He was lazy but he told us great stories,” “He could play the drums better than anyone else in the village,” “I remember when he took us all to the capital of Accra and we had a great time,” etc. (The first playing should not focus on factual information—go for feeling, facts can be added later.)

After the funeral—Teacher as narrator: “That night Ananse opened one eye, then another, then a big smile came over his face. It worked. He slowly climbed out into his garden and grabbed as many vegetables as he could carry, took them into his hole, cooked them, and ate them all up. Then he went to sleep. He did this for seven nights and days, until Mrs. Ananse walked out into the garden. Watch!” Mrs. Spider is aghast at the loss of her vegetables. She builds a scarecrow and covers it with goo from a sticky goo tree. Ananse wakes and after asking who is in his garden, hits (pretends to hit) the scarecrow. (Teacher must demonstrate a pretend hit!) The family, neighbors and Mrs. Ananse force him out of the village into a dark corner.

Each time through the teacher takes less and less of a role until the students can act it out by themselves.
SAMPLE LESSON PLAN #3

Drama Mode
Dance/Movement

Purpose
To know a Russian dance.
To experience the relationship between feelings and body movements.

Activities
There are many ways to teach students a dance. A “professional” can be called in to teach the dance. The teacher can learn with the students and practice with the students when the Dance teacher is not there. The Music teacher or Physical Education teacher can teach the dance. There are many books which describe dance steps. The teacher can practice on her own and teach the students herself.

The following dance, a Russian Troika, was dictated over the telephone to me by Ada Wilson, a member of an International Dance group. (She led an excellent Folk Dance Workshop for New Haven Music and Arts Teachers.) She will go over the dance in person with me before I teach it to my students in the next school year.

I am not concerned if my students do not dance the dance like the Russians. I am concerned that they participate and dance it to the best of their abilities and get a feel for the sound and movement of the people of Russia. A cassette tape of a Russian Troika, courtesy once again of Ada Wilson, will be available at the Institute Office on Wall Street.

There should be at least 18 people. They need to be in groups of three. (If the group is not evenly divided by three, improvise with a group of two or four.) Arrange groups of three, holding hands, making a circle. (Three in front of three, in front of three, etc.)

1) Eight big leaping steps forward.
2) Eight big leaping steps backward.
3) Person in center lifts left hand, making an arch with his/her partner on the left.
4) Person on the right goes through the arch, in eight steps.
5) Person in the center turns under arch in place—in eight steps, then all hold hands.
6) Center person lifts right hand, making an arch with his/her partner on the right.
7) Person on the left goes through the arch, in eight steps.
8) Person in the center turns under arch in place—in eight steps, then all hold hands.
9) Grapevine 16 steps clockwise (right foot crosses in front of left, left foot back left, right foot crosses in back of left).
10) Grapevine 16 steps counter clockwise (left foot crosses in back of right, right foot back right, left foot crosses in back of right).
11) Repeat from the beginning. This time on the 8 big steps forward, the middle person takes bigger steps and walks into the middle space of the three people in front of him or her. This changes the three people all the time.

SAMPLE LESSON PLAN #4

Drama Mode
Role Playing

Purpose
To experience some of the problems resulting from changes which take place in a culture.

Activities
The students have studied Ghana for at least six weeks before this activity takes place. They have heard one Ananse story, learned one dance and can count from 1-10 in the Twi language. They are aware of the great culture of the Ashanti people and the extent of their influence in Africa at one time. They are aware of the fact that there are tribal chiefs presently in Ghana who have lost much of their power to the new form of government. The students have created some drawings and crafts typical of Ghana. They are told that the person visiting the class is playing the role of a chief, but they are asked to believe it for the sake of exploring some new ideas. (Students will accept this not only because it is fun, but because they do it all the time with television.)

A visiting artist from Ghana is hired to dress as and play the part of a modern chief from a village in Ghana. The chief is visiting the class to plead for help.
"My culture is fading. There are too many changes. What can I do?" (This could be video taped.)

The students and teacher(s) will become engaged in a conversation. The teacher can best serve the situation by helping to direct questions or making statements which cause students to think in a new direction. For example the classroom teacher might play devil's advocate and say, "You should accept facts. Times have changed. You no longer can make the laws." The teacher could also say, "Is there not a place where you can go with your people and not be bothered by the new ways?"

After approximately thirty minutes the person in role should leave, change into "western" clothes and come back in as himself to discuss what happened. It is this period of reflection which will be most important. (If the situation was video taped, the video tape can be used to review what happened, and will increase the impact of the event.)

(Another way to do this activity is to have the class become members of an Ashanti village in Ghana. A person in role enters as the government Minister of Transportation to discuss the movement of the village because of the new "super-highway" coming through.)

SAMPLE LESSON PLAN #5

Drama Mode

Improvisation (Dorothy Heathcote's "Mantle of the Expert")

Purpose

To experience the relationships between geographical location, natural resources and the development of a culture.

Activities

The teacher talks to students about the word culture. A discussion follows. The teacher asks students if they would be willing to create a new culture of their own. (The teacher needs to get their commitment, so if they should say no, present it in a new way, or present it to a different group.) Using markers and large pieces of paper, the teacher writes down important responses from students. (Where is the culture? Describe climate and terrain; list available natural resources.) It is important that their input is used if they are to feel any real ownership of the work.
The teacher asks what must be done first to establish the culture. (Using the categories of culture provided in the previous chart, teachers can lead students from their comments to the particular area of culture. For example, if a student says we need rap music, the teacher can direct the student’s attention towards the arts of the culture. Another method of classifying culture, which I think could work well with students in grades 5 and up: 1) symbolism, 2) value, 3) authority, 4) order, 5) ceremony, 6) love, 7) honor, 8) humor, 9) beauty, and 10) spirit. Students decide to name the culture (Nirvat, for example). (If names are suggested which cause silliness, ask that a new name be created. If a name seems silly only to the teacher, then the name can be kept.)

The teacher can lead the drama in two ways: from outside and from within role (as described in Sample Lesson Plan #1). There is an advantage to each method. From outside the teacher plays himself or herself, holding on to the traditional authority assumed by the role s/he is really playing. If the teacher uses a role within the drama, as s/he did as the spider child in the Ananse story, s/he becomes more equal to the students and can “guide” the drama as a participant. In this role the teacher actually gets an opportunity to “play” with the students. This is much more difficult for most teachers as it means giving up authority. (It is actually a safe way to experience this kind of drama, as the teacher role is always available.)

In the first lesson each participant takes a specialized role in the community: map maker(s), house builder(s), clothies maker(s), law maker(s), doctor(s), teacher(s), inventor(s), explorer(s), leader(s), constitution writer(s), flag maker(s), food grower(s), etc. It is best to make small groups of workers, unless a student works better alone or in a pair.

After all of these people meet with the leader the first drama ends. Before the second drama each student draws a picture or creates an artifact which will be used in the second drama. The map maker makes a map of the first town, the clothes maker draws a picture of the clothing worn by boys and girls, the flag maker designs a flag. Each drama from this point on will need to have tension to give dramatic form. Possible points of tension include: water supply is dwindling, possible attack by another culture, disease, the celebration of the first holiday, a group of people within the culture decide to revolt, or the leader becomes very sick.

Notes

4John W. Wright, editor, The Universal Almanac 1990, 481.
5E.D. Hirsch, Jr., A First Dictionary of Cultural Literacy, 121.
6Betty Jane Wagner, Dorothy Heathcote—Drama as a Learning Medium, 181.
7Ibid., 15.
8Brian Way, Development Through Drama, 8.
9Ibid., 6-7.
10Alice C. Omaggio, Teaching Language in Context, 361.
12Omaggio, 364.

Teachers' and Students' Bibliography

Resources marked by an asterisk (*) may be used by students.

Education/Culture/Multicultural Education


Cottrell, Robert J. “America the Multicultural” in American Educator 14, No. 4 (Winter, 1990): 18-21, 38. Focuses on why multicultural education is so important in America.


Newhill, Esko E. and Paglia, Umberto La. Exploring World Cultures. Lexington, MA: Ginn and Company, 1986. This gem comes with an incredibly useful, readable teacher's edition. It is available at the Center for International and Asian Studies listed under “Community Resources” in this bibliography. Although the book is written for 6th grade and above, materials can be adapted for the lower elementary. The HANDOUTS section of the teacher guide contains especially useful information on cultural concepts: rules, beliefs, values, how people listen and speak, exploring stereotypes, and categories of behavior found in all known human groups. Lists audio visual resources.
Melting Pot Theater


**Drama/Theater Books**

Kase-Polisini, editor. *Drama as a Meaning Maker*. Lanham, MD: University Press of America, 1989. 43 distinguished Drama educators respond to one of three professionals outside the field of Drama: a neuropsychologist, novelist and professor of psychology. Explores Drama as context.


Ghana, Africa


Asihene, E.V. Apoo Festival. Tema, Ghana: Ghana Publishing Corporation, 1980. Explains the importance of all festivals and the Apoo festival in particular. It represents the nuisances the community has had to put up with during the preceding year. Every person is given the right to criticize anybody they want. Details on the celebration of this festival are provided. Words and translations to songs are also provided.


Sarpong, Rt. Rev. Dr. Peter. Ghana in Retrospect. Accra, Ghana: Ghana Publishing Corporation, 1974. Gives considerable information on customs and rites of passage which can be adapted for the lower elementary. Covers religion, values, art and crafts, music, myths, etiquette and more.

Puerto Rico


**Russia, Soviet Union**


Morton, Miriam, ed. *A Harvest of Russian Children's Literature*. Berkeley: University of California Press, 1968. Older students can read some of this. This is the book to use for short poems, stories, verse, fables and works by famous Russian authors. A Baba-Yaga story is on page 149.

Vandiver, Rita and William. Young Russia, Children of the USSR at Work and at Play. New York: Dodd, Mead & Co., 1960. Although relatively old, the pictures do not look very different from many scenes I saw when in Russia in 1989.

Community Resources/Audiovisual Aids

The resources listed are specific for New Haven, CT. Hopefully similar local resources are available in your community.

Casa Cultural Julia de Burgos, Yale University
Center for Puerto Rican Study
301 Crown St. New Haven, CT. 06520
432-0856
Dean Carlos Torre
Primarily historical and political books in Spanish. Contact for people resources.

Council on African Studies, Yale University
89 Trumbull Street New Haven, CT. 06520
432-3438
Maxwell Amoh, Director (Also an artist from Ghana who leads a performing group named Agoro)
Many books, audiovisual bibliography, music, contacts and more!

Foreign Language Department-New Haven Public Schools
21 Wooster Place New Haven, CT. 06520
787-8685
Mary Lowery, Supervisor of Foreign Languages
Lisette Bernier-McGowan, Supervisor of Bilingual Education
Kay Hill, Curriculum/Staff Developer for the Bilingual Program

International Folk Dance Group
18 Water Street Guilford, CT. 06437
453-3263
Ada Wilson, Contact and Dancer
Ada taught a dance workshop for New Haven Music and Arts teachers. She is very helpful and knowledgeable about folk dances around the world.

New Haven Public Schools-Audio Visual Center
Wexler School 787-8687
Dr. Asarita, Director
There is a catalogue of available materials.
Russian and East European Studies, Yale University
85 Trumbull Street New Haven, CT. 06520
432-5963
Brian Carter, Director of Russian Studies
A veritable treasure trove of materials, including books, filmstrips with cassettes and people contacts.
Who Do You Think You Are?

Bill Coden

There is no remembered past; there is no predictable future. My students seem to be mired in an everlasting “now,” a time period which acknowledges neither yesterday nor tomorrow.

This “now” is a dangerous place to be because it fosters a sense of disconnect-edness which is reinforced by the traditional middle grades set-up of fragmented time and space. Rather than flow, learning must take place in rigid time-slots with little possibility or opportunity for meaningful follow-up activities.

“Now” also encourages an act-react behavior pattern to emerge. Situations must be met head-on. Little or no time or opportunity for reflection is possible. “What do I do now?” replaces “How did I get to this point? Where do I go from here?” This pattern affects teachers as well as students.

“Now” excludes the possibility of unexplored potentialities. “Now” always is and always will be. Aspirations are unenvisioned.

I intend to develop *Who Do You Think You Are?* as a Humanities/Language Arts course suitable for seventh- and eighth-grade students in an arts-magnet middle school. The philosophy of the school encourages teachers in the arts and the academics to make subject-area crossovers whenever possible; teachers, as well as students, are encouraged to stretch and to grow. (As my concluding comments will indicate, I have since taught this unit in several different school settings.) The unit, of course, must be adaptable for students with varying reading, writing, and social skills. While the unit will explore one subject—the self—in depth, the experiences and activities will provide the breadth which Van de Bogart feels is so essential in a Humanities course. It is not an objective of the unit to produce a student “who knows more and more about less and less.”

*Who Do You Think You Are?* will allow my students to remember, discuss, and record significant events and people in their lives. They will discover the reality of the past. Remembering, a solitary activity, will be more than reminiscence; reasons and patterns will be sought. Discussions will be both small- and
large-group. Recording will be either written, taped, or pictorial (as indicated by lesson plan).

My students will come to recognize and realize their uniqueness as individuals and as group members. Who Do You Think You Are? will be part of our everyday life—not a unit featured for a few weeks and then forgotten. “Group” therefore refers to our classroom as well as to our families. Theater games stressing trust, cooperation, and a sense of community are an integral part of the unit; the good which can come from these activities goes beyond the unit.

Students will come to recognize and attempt to project the future as a result of knowledge gained through unit activities. Work on cause-effect relationships and creative problem-solving will help us achieve this goal. The dreams and aspirations of Lorraine Hansberry and Anne Frank will be read, discussed, and compared to our own. “Tomorrow’s News Today” will allow us to videotape our probable—and our fantastic—futures.

The development of facility in reading and writing is the heart of the unit. Excerpts from autobiographies will be read and discussed. More importantly, the excerpts will serve as models for student-written autobiographies. Identifying the voice of a writer is an important facet of this objective. The process of identification will help students find and maintain their own voices in their writings. Revision of writings will be part of the process from the beginning. Revision—or reconceiving—will be done because everything has possibilities. A higher level of success or insight may be achieved by approaching a reading or writing assignment from a different angle. Helping students understand that a problem may have a number of possible solutions is important.

Specifically, each activity in the unit will be composed of:

I. LEAD-UP

A theater exercise will usually precede a reading assignment. While the development of a sense of community and cooperation will always underlie the choice of a theater game, the exercise should have a direct connection to the theme of the selections which will be read and discussed. “Personal Scenes” will allow small groups of students to share turning points, choose one memory to be dramatized by the small group, and presented to the class. Turning points may be highly dramatic or just slightly out of the ordinary. These ideas will be emphasized during the reading and discussion.

Theater games are valuable tools because concentration is of paramount importance in each activity. The exercises lend themselves nicely to this unit
because there must be a progression: a beginning, a middle, and an end to each activity—a yesterday, a today, and a tomorrow.

Because I would want to start the unit at the beginning of the school year, I’d take certain precautionary measures.

The introduction of theater games into the classroom would lay the groundwork for building a sense of community, trust, and cooperation. We will begin finding out who we are from the first day of school. Warm-up exercises (alphabetizing ourselves by first name or street, arranging ourselves numerically by birth date or shoe size) will help us to focus on ourselves individually and as group members and will introduce the concepts of revising and reconceiving.

If a part of an activity proves painful for a student, he/she should be allowed to opt out of the exercise or to reconceive an approach to the problem. If “Personal Scenes” was indeed too personal, perhaps the student could be encouraged to make up a memory to be shared or to fuse together parts of several memories. Such flexibility will help in the building of self-confidence and responsibility.

II. LITERATURE

Selections from a number of autobiographies will be read and discussed in class. The readings will be used as springboards for student writings. Specific readings will prompt specific points of discussion. The areas mentioned later in the unit are suggestions; there may be topics you feel would be of more importance to your students. Pursue them!

All discussions of the literature we read must deal with the phenomenon of voice. Such discussions should elicit the individuality of the writer under scrutiny. How does he/she sound? What is he/she telling—or not telling—us? Excerpts will be analyzed for both word selection and overall structure. The analysis should not, I feel, overshadow the thematic discussion though it is invaluable to the writing the students will be doing. A fine line has to be drawn. As with revision, I’ll stress the approach rather than the mechanics.

The literature (and subsequent writing assignments) will be grouped in broad categories. I’ve drawn the categories from student interests as well as needs I’ve recognized. The categories include:

A. Early memories
B. Superstitions/Family wisdom
C. School
D. First love
E. Responsibility
F. Tragedy
G. Turning points (rites of passage)
H. Trends
I. Place
J. Future

Autobiographical books, excerpts, poems, and recordings would be available for students to use in “free” time in school and at home. These materials would be selected for pleasure as well as for information. Books which have been excerpted will be available in the classroom library; a file of biographical and autobiographical articles from sports and entertainment magazines will be developed. It is important that students become familiar and comfortable with the idea—as well as the reality—of autobiography.

III. WRITING

Writing assignments would range from the broad (“Make a list of ten words which describe you.”) to the more specific (“What qualities distinguish you from your friends? your enemies? your family?”). The progression that is important in the structure of theater games is as important in the structure of the writing assignments.

In order to circumvent the “That’s too personal!” response, the writing activities at the beginning of the unit emphasize the general. A questionnaire format is reasonably non-threatening to students bred on filling in the blanks. Before long, it will become easier to introduce “thought questions” into the format. These “thought questions” can serve as the basis of expanded writing assignments. Lengthy reliance on the questionnaire format would be self-defeating and deadly.

As stated above, writing assignments will grow out of the discussion of specific autobiographical readings. In order to stress the importance of voice in autobiography, an experiment might be conducted with students. “How would you—as Frederick Douglass or Zora Neale Hurston or Anne Frank—describe the theater game we played earlier?” Such an activity, early in the unit, would give students a solid base for finding and reproducing their own voices in their autobiographical writings. We might also do a theater activity called “Whose Story Is It?” Students would pair up, each in turn share an incident, choose one, and then both relate the same incident to the class which would then try to
determine whose story it was. The storytellers are coached to keep the story line accurate but make the story their own—embellish it, use their own voices and gestures. The goal is to adapt rather than to trick.

Though I've belabored the point, the sense of community and cooperation being established will give students freedom to explore, express, and share themselves. Risk-taking will become less threatening. Environment must play a tremendous part in the depth, breadth, and honesty of students' response to autobiographical writing assignments. Though the teacher is the immediate audience for the writings, the value of the process ultimately lies with the students.

IV. FOLLOW-UP

I have chosen to make the Humanities especially important in the follow-up activities. In addition to providing further opportunities for self-expression and self-exploration, they will reinforce the theme of "connectedness" which underlies the unit. I'll make as many crossovers with the academic and arts disciplines as I can, to satisfy myself, my students, and my school.

Creative problem-solving and values clarification activities will lead to rudimentary discussions of philosophy. Approaching problems from many angles will again be stressed. The creation of time-lines, neighborhood murals, and floor plans will lead to investigations in architecture. We'll recognize our separate neighborhoods as parts of a whole. What makes our neighborhood or home or room special to us? Family traditions, superstitions and record-holders will be gathered through student-conducted interviews. Perhaps adults will be recognized as sources of information as well as authority. The design, as well as the execution, of the interviews will come from the students and will touch on a number of subject areas.

Self-portraits and family portraits will be juxtaposed with a study of fine art portraiture. Snapshots will be brought in from home and used in a number of ways. Snapshots capture one moment in time. What happened just before and right after the camera clicked? The stories would be based on fact with details to be supplied or re-created. The past is not always readily available to a writer (Frederick Douglass, Maxine Hong Kingston); it must be imagined and created.

Students will discover their voices in many media. The opportunities for making connections are virtually limitless and extremely important.

A tangible end-product of Who Do You Think You Are? will be an autobiographical booklet, two-fold in nature: a collection of personal writings and observations and an anthology culled from the former which could be shared
with parents and other classes. The Humanities activities, which can’t be included in the booklets, are vital to the production of the writings.

Obviously teacher-awareness of students’ environments and capabilities would influence the nature of the activities chosen for use. A working-file of ideas and observations would be helpful in forming and re-forming activities suitable to particular classrooms.

I wrote and first taught *Who Do You Think You Are?* in 1982; parts, as well as expansions, of the unit have been central to my teaching ever since. In 1982 I was teaching in an arts-magnet middle school which had changed some of the traditional rigidity we’re all used to: periods were lengthened and/or combined so teachers spent more time with students each day; teachers were encouraged to work with each other across, as well as within, guidelines for the arts and academics. These factors contributed to the successful teaching of the unit, as written. There was the time and the continuity necessary to complete the activities. Currently I am teaching in a program for talented and gifted public school students. While seventh-grade students meet for a long period of class time, they meet as this group only once a week.

It’s been necessary to make alterations in the unit, most of which are dictated by time-structure. What were formerly lead-up activities are now done as follow-ups in the afternoon; greater emphasis is now placed on writing and on including a wider variety of literature; arts activities have been abbreviated. For the most part, each “lesson” is begun and completed in one weekly class session.

While this is less than ideal and certainly different from what I’d intended, the writings produced and thoughts expressed continue to encourage my belief in the value of autobiography in the classroom. New material continues to present itself, as I continue to become more aware of autobiography, the many forms it can take, and the richness it can bring into the classroom. Over the course of the years, some ideas were scrapped; they were too dated or too difficult or too facile. Many more ideas, however, were generated and added to the unit.

I have participated in two other Yale-New Haven Teachers Institute seminars on autobiography and have written two more units. While I believe each unit, written to respond to a specific need or to explore a certain approach, could be taught on its own, I am most comfortable combining elements from each.

*I Am ...* (1988, vol. 3, 56-59) centered on journal-writing as a way of remembering. The goal of the writing is to gain an understanding of our lives and a recognition of our self-worth. When we help students choose form, voice, subject, and audience, we give them responsibility and ownership for their writing. Though the majority of the readings in this unit are excerpts from longer autobi-
ographical works, different sources for reading and writing activities were recognized and used: autobiographical poems and fictions, photographs, and slave narratives. Discussion, rather than the reading journal described in the unit, proved to be of more value as a lead-in to personal journal writing.

*Remember* (1990, vol. 1, 21-31) is an attempt to make our reading and writing program more representative of our school system's cultural diversity. Rethinking the practice of the two previous units afforded me the chance to strike a finer balance between the universal and the unique. The unit offers an overview of the history of Hispanic-American literature as well as Chicano literature, a literature of self-search and social protest. The unit focuses on the work of Lorna Dee Cervantes, a Chicana poet whose voice speaks of her roles as Chicana, poet, and scribe. Writing suggestions given in the lesson plans emphasize poetry but could easily be treated in prose.

The following overview contains the selections and suggestions written in 1982; they have been reordered so that they move from the general to the specific; from the non-threatening to the more intimate; from the universal to the unique, as perceived by my students and me. The unit, whole or in part, has been taught to remedial, average, and gifted and talented seventh- and eighth-graders.

The lead-up activities progress from "fun" warm-up whole-group games to more thought-provoking small-group and individual activities. Difficulties students might experience with themes and in reading ability are fairly evenly-spread. Though the opportunity to teach specific skills (adding details, sequencing) and forms (script, song lyrics) is there, the reordering reflects, more than anything else, my desire to have students become more at ease with the act of writing.

A GENERAL OVERVIEW

1. Early Memory
   A. Lead-up: Thinking Back (stream-of-consciousness)
   B. Literature: “Knoxville, Tennessee” — Nikki Giovanni
      *A Mass For The Dead*, pp. 26-27
      *To Be Young, Gifted, and Black*, pp. 48-50
   C. Writing: select an early memory; expand, add details
   D. Follow-up: reconstruct the place of your memory
      Nikki Giovanni filmstrip

II. School
   A. Lead-up: Ask/Reject: a problem-solving activity in which a player tries to elicit the cooperation of his/her partner in granting a wish; the part-
ner has been instructed to reject the request unless he/she is fully persuaded. Approaches to the problem must be reconceived.

B. Literature: Manchild In The Promised Land, pp. 154-57; Narrative of The Life of Frederick Douglass, pp. 33-46; I Know Why The Caged Bird Sings, pp. 142-56; Down These Mean Streets, pp. 69-74

C. Writing: directed memory (chronological)

D. Follow-up: special teacher—Who? Why? ideal teacher

III. Family/Family Wisdom

A. Lead-up: Composite questionnaire: What do you do for good luck? How do you avoid bad luck?

B. Literature: Black Boy, pp. 16-21; To Be Young, Gifted, and Black, p. 53; I Know Why The Caged Bird Sings, pp. 21-27; I Love Myself When I Am Laughing . . ., pp. 28-32; "Lies," p. 106

C. Writing: interview: family superstitions, traditions; transcribe

D. Follow-up: create a good luck charm

IV. Place

A. Lead-up: Blueprint (current home, early home)

B. Literature: Notes Of A Native Son, pp. 47-48; The Story Of My Life, pp. 20-21;
   "Apartment House," p. 39;
   "Vacant House," p. 167

C. Writing: guided tour of blueprint (written; videotaped)

D. Follow-up: Neighborhood mural

V. Love

A. Lead-up: Anonymous Valentine

B. Literature: I Know Why The Caged Bird Sings, pp. 8-11
   I Love Myself When I Am Laughing . . ., pp. 70-74
   "Valentine," p. 124
   "The Picnic," p. 62

C. Writing: write lyrics to a love song; listen to—hear message of—love songs.

D. Follow-up: Love Day: students bring to class and share inexpensive tokens of love they've been given; love poems are read and discussed; symbols of affection—the heart, Cupid—are discussed.

VI. Responsibility

A. Lead-up: Airport: this is a theater game which stresses giving and receiving directions; accepting and giving over responsibility. See Bananas for a full explanation.
B. Literature: *I Know Why The Caged Bird Sings*, pp. 142-56  
   *A Choice of Weapons*, pp. 220-22
C. Writing: re-create an incident when you were “in charge”
D. Follow-up: Thank You Note

VII. Turning Points
A. Lead-up: Personal scenes
B. Literature: *Black Boy*, pp. 9-13  
   *Autobiography of Malcolm X*, pp. 21-22  
   *A Choice of Weapons*, pp. 11-12  
   *I Love Myself When I Am Laughing . . .*, pp. 40-45  
   *The Story Of My Life*, pp. 32-35  
   **“Growing Up,” p. 40**
C. Writing: “I used to be . . .”
D. Follow-up: Time Line — visual points to be expanded in writing

VIII. Future
A. Lead-up: Best Thing About Me (Now)
B. Literature: *To Be Young, Gifted, and Black*, pp. 259-63  
   *Anne Frank: The Diary Of A Young Girl*, pp. 80, 233-37.  
   *Manchild In The Promised Land*, pp. 426-27  
   **“Dreams,” p. 129**
C. Writing: Tomorrow’s News Today (script for news program)
D. Follow-up: Success Symbols (share, discuss)

* in *Reflections on a Gift of Watermelon Pickle.*  
** in *Some Haystacks Don’t Even Have Any Needle.*

SAMPLE LESSON PLAN: EARLY MEMORIES

**Lead-up**

Try to recall the first thing you can actually remember happening—not something  
you were told happened. Record the memory on paper; continue writing, letting the  
mind wander across time for five minutes. (Music, “Jupiter Symphony,” is helpful.)

**Literature**

“Knoxville, Tennessee,” by Nikki Giovanni. What senses are appealed to? How  
is Ms. Giovanni able to sound like a child? What is important to this child?
Autobiography of Malcolm X, pp. 1-2. Even before birth, Malcolm X seemed destined to live a life of drama and violence. What elements of drama are present in this short selection? What can we guess about this person by looking at the words (especially verbs) he has chosen to use?

A Mass for the Dead, pp. 26-27. The author presents himself as a character in a story. Why is the incident so important to him? How does he give examples of cause-effect relationships?

To Be Young, Gifted, and Black, pp. 48-50. What gives Lorraine an early sense of her uniqueness? What makes you unique? In what ways are the memories of Lorraine and Nikki similar? Where do you wish a GIANT STEP would lead?

Writing

Select one of the memories from the list you worked on earlier. Expand it: give it a beginning, a middle, and an end. Feel free to invent details which would enrich the story. (The group could later discuss the criteria used in making choices: drama, happiness, tragedy, appeal to the senses, etc.)

Follow-up

Try to reconstruct the place of the memory you chose to write about. Can you see the place in your mind's eye? Using paints, inks, crayons—any of our art materials—give a representation of the place. (The activity could be done in conjunction with an art teacher. Group discussion could center around what was most important about the place: color, size, students' feelings, etc. The representations should be displayed in the classroom.)

SAMPLE LESSON PLAN: PLACE

Lead-up

Using simple materials (paper, pencil, or marker), draw floor plans or blueprints for the last two houses or apartments you've lived in. Set up your own measurement scale.
Literature

*Notes of a Native Son*, pp. 47-48. Baldwin creates a character out of a place. What is a "casual" face? In this case, why is the casualness deceptive? Describe the character's life. Describe the author's tone of voice.

*The Story of My Life*, pp. 20-21. What senses are appealed to in this selection? Why do you think the garden—rather than the house—is so lovingly described? Reread the short selection. What tone of voice do you hear?

"Apartment House," by Gerald Raferty. What attitude or tone is conveyed in the poem? How would you describe an apartment house?

"Vacant House," by Jeanne De L. Bonnette. A scene is conveyed by concentrating on what is missing or lacking. What do you feel is the most important element of "home?"

Writing

Look at the blueprints or floor plans you drew earlier. Please write a commentary for a walking tour through one house or apartment. Describe the rooms, furniture, the places you used to study, play, day-dream, hide, sleep, etc. Include memories as they occur to you.

Follow-up

(Divide class into neighborhood groupings; aim for groups of 3-7 people.) Using markers, crayons, and large poster paper, draw a mural of things, places, and people in your neighborhood. Include things which you feel make your neighborhood unique. You might want to include a detailed street map as part of your mural. (The murals should be displayed in the classroom. Materials on architecture and a map of the city are useful in this activity.)

SAMPLE LESSON PLAN: THE FUTURE

Lead-up

Today you'll have the chance to be in the spotlight and to see others in the same situation. One by one each of you should step before the video camera, say your name, and briefly tell the best thing about you now.
Sometimes it's a shock to see yourself on a video playback. Let's talk about how you felt when you saw and heard yourself and others. Were you yourself? What makes you yourself?

Literature

To Be Young, Gifted, and Black, pp. 259-63. Lorraine felt she was in the process of living her dream. How was she able to do it? What vision of the future did Lorraine hold? In which section did she come close to the oratorical skills of Frederick Douglass? Why is oratory important in this section?

The Diary of a Young Girl, pp. 80, 233-37. The early dream of the future sounds like a longing for the ordinary. Why is this dream so important to Anne?

In the latter section, Anne feels she's being more realistic. Do you agree? Why? Why not? What does the future now center on?

Anne steps outside herself in the last section. How does she see herself? Try doing the same activity, using yourself as the subject.

Manchild in the Promised Land, pp. 426-27. What influence did fear have on Claude's vision of the future? How does he separate "challenge" from "fear?"

"... That's all that matters, that a cat does what he wants to do." Do you agree or disagree?

"Dreams," by Langston Hughes. Using symbolic language, how would you define a dream? How would you define the absence of a dream?

Writing

We're going to work on a video project—the creation of a news show of the future with ourselves as the newsmakers. Scripts will have to be written: news stories will be based on what we've shared with and learned about each other; commercials should center around our interests. Groups will be needed to coordinate writing, building scenery, delivering news, and taping the show. Use the skills you developed in the family interviews for this news show. (News items can be taped "on location." Students can costume themselves as they might appear in the future. Students may exchange roles. A lot of coordination and cooperation is needed in this activity.)
Follow-up

Bring in success symbols—things which illustrate your achievements, things you've worked hard to attain, things which are important to you. We'll share and discuss them.

Notes

1Doris Van de Bogart, Introduction to the Humanities, 5.
2Frank Thomas, How to Write the Story of Your Life, 5-6.

Teacher Bibliography


Bananas. Center for Theater Techniques in Education, 800 Dixwell Avenue, New Haven, Connecticut. A rich source of multi-arts activities based on theater activities and practices. I've found it an invaluable source of ideas.


Both of Dunning's books are fine collections of thematically arranged poems which appeal especially to fifth- through eighth-graders.

Jaffe, Charlotte. Discovery Unlimited: Thinking Through the Humanities. Phoenix, Arizona: THINK INK Publications, 1981. Activities using critical thinking skills as an approach to the areas of art, literature, music, and architecture. Sections on music
and literature are very good. The unique angles of approach to "creative" areas tie in with the concept of "re-conceiving" in the unit.

Thomas, Frank P. How To Write The Story of Your Life. Cincinnati: Writers' Digest Books, 1984. Written by a teacher and journalist, this book offers many research/writing suggestions. The chance to review your life and gain new insights is stressed.


Student Readings

The following bibliography has been updated, reflecting additions to and replacements for titles on the 1982 list. The stories and poems listed below have been taken from class sets and single copies of books which I have. They will serve as the unit's core reading; many will be used to develop writing activities.

Angelou, Maya. I Know Why the Caged Bird Sings. New York: Bantam Books, 1971. Beautifully illustrates the experience of "ordinariness" — school, first love. Reading about the ordinary will help students start where they are in their writing. Strong focus on details.

Baez, Joan. "My Father." Baez presents a physical, social, and moral portrait of her father. The clustering of memories is a technique students may wish to use in their writing.


Chisholm, Shirley. "Back to Brooklyn." Chisholm reminisces about being kept on a tight rein by her parents, who wanted her to grow up to be something. The opening section is a good example of place memories.


Sanchez, Roberto and Oscar Lewis. "The Time I Ran Away." Sanchez describes the first time he ran away from home, prompted by a need for adventure and freedom from his family. After barely subsisting for three months, he returns home to be welcomed rather than punished, as he'd expected.


Walker, Alice. "To Hell With Dying." Walker presents a loving picture of Mr. Sweet, an elderly neighbor she later realizes was her first love. A humorous recounting of a "revival" from one of Mr. Sweet's many encounters with dying segues into the recognition of loss, aging, and love.


The seagulls were making sweeping spirals against the blue sky; it was a quiet summer day along the river in the Fair Haven section of New Haven.

The old man gazed into the distance. “You know,” he said, “Dover Street was named for a famous seaside resort in Dover, England, with its white limestone cliffs. In Fair Haven, the street used to end at the Quinnipiac River. There used to be a sandy beach where swimmers came; it was called Dover Beach. There were bathhouses—not enough for men and women at the same time, so the men would use them one day and the women the next.”

“You went swimming there?” the young boy asked.

“No, that was even before my time, back in the early 1900s. Later, when Clinton Park was built, Dover Street just ended there and a few years later the bathhouses burned down . . . around 1925. People stopped swimming soon after when the river got polluted.”


“Chatham in England was a naval base and ship-building town; most likely, one of the Fair Haven property owners had come from there and Fair Haven being a ship-building center . . . well, what better name!” he replied.

“There must be lots of streets in Fair Haven that have a history to them,” the boy stated.

“Yes, there’s history here. Fair Haven is a special community with an interesting past . . . very interesting,” the old man responded as he looked out over the river . . . and beyond.

Street names, places, events . . . recollections of a neighborhood, an area, a community . . . clear memories of a past often transmitted by stories told by an older generation. For them, there exists a real connection of sight, sound, smell,
and feeling for a place that became woven with their human life experience. In time, the young may come to develop this connection with what was before, and it will make their lives richer. But for many of my students, there is no human connection with their present community. For this reason, the unit will focus on their community, Fair Haven, within New Haven.

TEACHER NOTES

Within two years of the founding of the New Haven Colony in 1638, farmers were using the arable land in the so-called Neck, a flat area, east of the colony’s center between the Mill and the Quinnipiax rivers, now called Fair Haven.

While Fair Haven is the focal point of this unit, the topic of community is an important concept for students to understand. Wherever people reside, there exists a community in its broadest definition. The richness of any community can be translated by studying its common interests, unique heritage, geographical location, historical development, work, or social interaction. No matter its accident of location, a community shares a spirit of togetherness. Thus the goal of teaching about community can create in students a spark of interest that can ignite a curiosity in a larger world, both past and present.

This unit is designed to be used with eighth grade social studies classes at Fair Haven Middle School in New Haven, Connecticut. The school is located near the center of the community close to the crossroads, Grand Avenue and Ferry Street, about a mile and a half from New Haven’s commercial center. This unit should serve as an introductory activity early in the school year in American history or Western Hemisphere courses. The unit is aimed at low and middle achievers to get them located in place geography and make them aware of the history of their community.

The unit’s objectives are:

1. to understand the concept of community.
2. to become aware of some of Fair Haven’s heritage.
3. to learn place geography through mapping activities.

Because the study of a community can be complex and involved, especially over the course of time, this unit presents three topics that illustrate historical development and change—the role of oystering, the influx of immigrants, and industrial growth. Through teacher discussion, Fair Haven may become more than a place in which to live, work, and recreate; it may become a community with a past. Slices of the past, through the related fictional stories, will provide
the needed sense of change over time. The stories which I have written show that stress and change are common in any community. They can be duplicated and read by the students with the follow-up questions used as evaluation. The series of mapping activities will illustrate Fair Haven’s street geography and its place relationship to the area around it. The length of teaching time for this unit may be from five to ten class periods.

INTRODUCTION

As American society is changing, faster and faster, children no longer live in the same kind of community that their parents and grandparents inhabited. For centuries, children grew into adulthood in a world much like that of their parents; ideally, they were raised in a consistent pattern of life and maintained a basic familiarity with place and family.

Today, our society and its communities reflect change almost by decades rather than over the course of generations. The world is more accessible; there is a desire for what is new, more experiences and heightened sensations. The result may be disorientation and an erosion of traditions; contemporary life places stress on human communities and on the individuals’ search for meaning. Values become lost without the roots of the past and a continuity of time.

The nature of the family as a social and economic unit has changed especially in urban settings such as New Haven. Once, the family was the center for social, recreational, educational, and religious teachings. In many ways, many of the functions that were once performed mostly by the family as a unit are now being performed mostly by other institutions in our society. Today, the family may only fill psychological and emotional needs, and not always in all cases.

Once traditional neighborhoods, schools, and churches served as extensions of the family and provided the additional security to the individual. People have always worked in groups; sometimes the group was the community and sometimes it was based on nationality or culture. The Puritan John Winthrop foresaw a society in America as a community in which each person put the good of the whole community ahead of private concerns. Benjamin Franklin’s eighteenth century America, by contrast, viewed the individual free to make choices about his future and not be a submissive, unquestioning creature.

America was transformed by new types of communities that influenced tastes and opinions; the meaning of community took on new dimensions as America became a mass society. Modern life presents greater opportunity to be yourself, to be mobile, and offers a range of choices. The concept of community is placed
in conflict with the drive to be an individual. As communal forms of togetherness break down, especially in the family where there is little effective ethnic influence to restrain excesses of conduct, individuals feel less sense of belonging.

This unit is about community in the sense of locale, an awareness of its past and its place. The fact that the community has changed should not negate an attachment to it and its heritage. The struggle to be an individual is a given in our complex mass society. The trick is to balance community and person.

The teaching of the concept of community is important for the Middle School age group as they are maturing and socially expanding their experiences. To concentrate on their community will provide a deeper connection, a sense of belonging and pride. It is good to know where things are located. But it is more important to know why those places influence our lives. Knowing your community can be a step towards participation in one’s community. Supported with knowledge of its location in relation to the surrounding local region, students may take a step in building a personal bridge to the larger world.

At the beginning of the new school year, eighth graders re-enter the school community. Some students are multi-year building registrants, some are only recent members of the student body, while others are new to the school. The start of the year may bring mixed feelings: insecurity, hesitations, loneliness, confusion, renewal, confidence, and eagerness. Soon the majority adjust, relax, and get on with school life. The attachment of belonging may develop and even a sense of pride may grow; this is healthy and could be used to promote learning, social growth, and self-esteem. The students can directly feel the connection between themselves and the school; they can be a part of it.

The relationship with the family exists as well, good or bad; it is real and shapes attitudes and values before school years begin. The family, for most students, is their first community, a gathering of people with a common bond. It’s the most familiar, often the safest, and an ideal growing ground for an individual’s personality; it can be a community of love from which the individual ventures into ever-widening communities.

Thus, the community of the family and that of the school are known entities to students; they feel comfortable in relation to them for the most part. In their short lives, these groupings form the student’s major framework for reference to the larger world; in a sense, the family is the nest of nurturing and the school provides the first branch beyond to the outside. But what of the other tree branches and the directions to which they stretch? What of the trunk of society’s tree that is rooted in the immediate environment?

The local community is another branch to the greater world; Learning Your Way Around is thus the direction in which this unit points.
"CLAMTOWN"

Fair Haven is a unique community located approximately two miles from the New Haven Green. Early references cite "Dragon Point," "Dragon River," and "Dragon Town," so called, no doubt, because of the harbor seals that inhabited the banks of the river when sailors first visited the area. Although a part of the New Haven Colony, its original farmers formed a separate village in 1679. The first wooden bridge across the Quinnipiac River in the late 1700s brought together both sides, helping the "Farmes" develop independently until 1784 when the areas between State Street and Mill River became part of New Haven. This area was called "New Township"; as the settlement of Fair Haven grew near the river, it again separated from New Haven in 1837 and boasted of a population of 1000.

Oystering and the advantages of the Quinnipiac River gave Fair Haven reason to exist and earned it the nickname, "Clamtown." Almost all of the inhabitants were in some way involved with the oyster industry—building sharpies, manufacturing kegs, cultivating and harvesting oysters, or buying and selling the natural resource. By the middle of the 1800s, Fair Haven's oyster trade ranked second to Baltimore's in volume.

During the early years, Fair Haven proper was little more than a cluster of fishing huts along the Quinnipiac River. But by the mid-1800s, it was thriving, and "Fair Dragon" began to be called by its proper name. A sea captain who visited the place in 1747 was so impressed by its beauty that he referred to it as "Fayre Haven." Besides the oyster boats, the river was the home to large vessels which carried on a trade with the West Indies, bringing sugar, molasses, and fruit to New England. Seafarers made Fair Haven their home port. The First Church on Grand Avenue had forty-eight ship captains among its congregation. The 237 foot spire of the church was a landmark for many returning sailors until one hundred feet were removed in 1877 after a storm.

With access to New Haven harbor and bordered by two rivers, Fair Haven developed a maritime industry. It was the oyster industry that played the dominant role as the major economic factor until the eve of the twentieth century. The oysters were plentiful in the beds at the bottom of the rivers and along the shores of Long Island Sound. The oystermen gathered the oysters with rakes and tongs, and when their boats were full, headed to the shore. There, the oysters were wheelbarreled into houses along the river through an entrance in the high stone cellar. Here, the oysters would be measured, opened, washed, and packed. Later, large shops were opened for the marketing process. Boys and women labored from September to April opening the oysters on a piecework
basis. An expert could open one hundred quarts a day; the average was about sixty-five quarts at two and one half cents per quart. Once packed in kegs, they were surrounded with ice to await shipping.

Secondary businesses grew as a result including those of barrels and boxes but boat building became Fair Haven's second industry. Originally, dugouts were used but as oystermen ventured farther out into the Sound the addition of a sail became necessary. The next major improvement was the development of the Fair Haven "Sharpie." It was a long (twenty-five to sixty feet), narrow sail boat designed to carry two men. With a flat bottom, the "Sharpie" provided steady footing for the oystermen as they scraped the bottom for oysters. For speed, two masts were used with triangular sails; this provided the speed needed to get home quickly with the catch. By the 1880s, two hundred "Sharpies" could be found along the Quinnipiac River. It was economical to build, easy to sail, and sea worthy. Its speed made it a popular racing boat into the twentieth century.

In 1858, two million bushels of seed oysters (smaller than three inches) were shipped on two hundred and fifty schooners for use to replenish the oyster beds in Fair Haven. The natural New Haven beds had been over fished and the oyster was almost extinct. From then, oystering—the seeding and breeding—changed from a simple gathering process to an organized, scientific farming process. Expanding oyster planting moved the growers farther off shore, and eventually the oyster companies moved to Long Island where the water was cleaner and they were closer to the New York market. Fair Haven waters were left solely as a breeding ground for the oysters up to the age of two or three. The shells of the opened oysters are dumped onto the river and harbor bottoms so that the young oysters can cling to them and mature.

Pollution and the oysters' natural enemies, the starfish and marine snails called "drills," brought the industry to its low. By 1930 only one oyster company remained, the Long Island Oyster Company, which still operates today out of the Quinnipiac River.

The original flat farm land had lent itself to supporting the early colonial settlers but development of the natural oyster industry had made Fair Haven a prosperous and busy place. With the oyster's decline, another economic base was needed to maintain the inhabitants. The natural resources of the Mill and Quinnipiac Rivers along with the harbor remained. They offered the promise for new businesses and the necessary transportation that would expand and continue Fair Haven's growth and development into the twentieth century. As craft shops and small industry developed in the early 1800s, the farmland was already disappearing around the edges of Fair Haven especially along the sides of the Mill River. The Farmington canal and then the railroad brought new workers
and their families to the area. The railroads, by increasing coastal and inland transport, resulted in a practical advantage that would attract new industry. Fair Haven was ready to be carried along by the second Industrial Revolution. Its maritime heritage would remain, but a new chapter was to be written in the community's history.\(^1\)

**THE RIVER AND THE OYSTER**

The sounds of their skateboards made the old man turn. He watched and admired the ease of the riders as they rode into the new park along the river. Turning back to his grandson, he was about to speak when he heard a slap and grinding noise. Again, he turned his attention to the young skateboarders.

“What are they doing?” he asked.

The small boy answered, “Oh, they’re just practicing ‘ollies’ and that’s a ‘grind.’”

The boards seemed to leap under the riders’ feet and then slam down on the metal trucks between the board’s wheels sliding along the outside rail of a park bench. Off into the air and down onto the sidewalk, they skated away.

“Always something new,” the old man said. “This park has seen a lot in its time . . . well, it wasn’t always a park, you understand. Not long ago there were docks for oil tankers . . . iron and steel was brought to the Schiavone scrap yard to be shipped to New York. Before the 1930s, South Front Street was boat docks and wharves where large schooners and sloops anchored with their bowsprits reaching over the street.”

“What’s a schooner?”

“It’s a sailing ship with two or more masts that was used to haul cargo to distant ports; the sloops were smaller with only one mast.”

The old man looked out across the Quinnipiac River towards the Heights and East Grand Avenue; he seemed to be transported back into the past . . . lost in his thoughts.

Then he said, “Front Street is probably the oldest road in Fair Haven; in colonial times, it was just a path used by fishermen. As time passed, the oyster helped make Fair Haven a prosperous community; the oyster, ship building, and trading ships with crews and captains made their homes along the river. One of the first settlers, Herman Hotchkins, owned a lot of property on both sides of the river; he built wharves for ships to tie up along, a store, and even a tavern. Exchange Street, behind us, got its name from an exchange office on the corner where oystermen could trade their oysters for merchandise or for money. When
oystering was big business, you would have found oyster barns and the oystermen's houses on one side of Front, and their sharpies or oyster boats and dugouts along the river banks."

"Sharpies!... What did they look like?" the boy wanted to know.

"They were long, narrow, and flat bottomed with a centerboard and one or two masts, each rigged with a triangular sail. They were stable enough in water for two men to stand and rake oysters from the river bottom. At first the oystermen used dugouts which were a lot like canoes, but they were heavy and didn't hold a lot of oysters. The dugout was replaced by the Fair Haven Sharpie... built right here; it was perfect for working the shallow river beds. They were called 'sharpies' because of their sharp looks and being very fast. When I was a boy, I remember them racing on the river."

"Oysters? They're fish?" the grandson asked.

The old man replied, "Yes, shellfish, and you can find them all along the shallow coastal waters of the Atlantic Ocean. Baby oysters, called 'spats,' need to be attached to a solid object in order to grow. That's why the old, empty shells are dumped back onto the bottom of the oyster bed. The shells are dumped back onto the bottom of the oyster beds. The shells are mostly made of limestone; the early settlers used to break up the shells and mix them with cement to make mortar. East Pearl Street got its name from the oyster, clam, and mussel shells which were spread over the dirt road as a topping."

"So where are all the Sharpies now?" the boy wanted to know. "What happened to the oysters?"

There was a pause as the old man decided how to answer. He remembered when he was young, his father used to work on an oyster boat during the harvest season to get extra money. He only worked on his days off from the railroad; the money was good but his father never liked the river much. His real love was the train... the noise and power of the steam locomotive... the adventure of travel to distant towns and different places. The old man himself had not gone oystering; when he was young, oystering was disappearing and since he was good at working with his hands, he had become a mechanic working at the Bigelow Company making steam boilers.

He pulled his thoughts back to the present and the sunny day along the river and answered. "There's only one oyster company left here in Fair Haven," he pointed, "across the river. Most of the companies moved to Long Island, but they still own or rent the oyster beds and use them for raising the spats. Times change, you know, and so did Fair Haven. The oyster business saw hard times when I was young. The oysters had been over fished, pollution from the factories spoiled the water, and the oyster's natural enemies, like the starfish, made
profits drop, and the businesses moved. The old docks and storehouses were used for other things.

"And what happened to all that stuff?"

"It got torn down. All those new houses were built and recently this new park. Sometimes it's hard to see the past."

The sounds of the skateboarders returned. "Things change," the old man said . . . "What are they doing now?"

"Nose wheelies," the boy answered.

**CHANGE AND COMMUNITY**

Time wouldn't let Fair Haven remain a rustic sea-going community. By the 1860s, it was a streetcar suburb with the Fair Haven and Westville Horse Railroad traveling along Grand Avenue. Its car barn, on Grand and Fillmore Streets, stabled four hundred and fifty horses; in 1893, they would be replaced by trolleys. The New Haven and New London Railroad built a bridge across the Quinnipiac River north of the Grand Avenue bridge and sliced Fair Haven from its depot in New Haven into East Haven. Now physically connected, Fair Haven, once referred to as "The Neck," merged again politically with New Haven in 1870.

The almost four thousand Fair Haveners witnessed new streets and in 1876 its ferry was replaced by a bridge across the Quinnipiac River, providing greater access and continued expansion. The earlier rural estates began to disappear. Among them was the thirty acre Maltby property which was subdivided into building lots. Elegant mansions with stables and greenhouses were transformed into low priced housing convenient to the developing factories. As developers built eastward across the Mill River, the farms began to disappear. Yet the ridge along the Quinnipiac River, Fair Haven Heights, flourished with new mansions with views of the river, East Rock, and Sleeping Giant. This area was becoming one of the city's affluent suburbs. The streets boasted of imposing Victorian Gothic, Greek Revival, Italianate Villas, and Queen Anne style architecture. These were the fashionable homes of the rich sea captains, merchants, and new entrepreneurs adding their touch to the landscape.

Grand Avenue and the adjoining streets became a melting pot of people packed into three- and four-story tenements along with new businesses and stores. The New Township section was the first to attract Irish immigrants after the Civil War. They were drawn by the railroads and growing industries; they were also employed in the genteel homes of wealthy New Haveners as servants.
Along with the Irish, an influx of Germans found their way to Fair Haven followed by Italians, Poles, Lithuanians, and Russian Jews. Many worked in garment factories and at the New Haven Clock and Watch Company, New Haven Quilt and Pad, Sargent's Candee Rubber, and in many other manufactories.

The river village was being surrounded by industry and was expanded by the people it attracted. Work brought people and the people formed ethnic communities connected by Grand Avenue which ran from New Township at State Street to the Quinnipiac River and the Heights. The Avenue, whose horse drawn streetcars ran every five minutes, connected people both rich and poor for work, play, and worship. The inhabitants developed a sense of identity with Fair Haven, of belonging to a neighborhood that became increasingly diverse after the Civil War, but united by shared hopes in a promising future on “The Neck.”

The greatest concentration of people was from State Street to East Street. At the corner of Grand and Artisan Street, named for the artisans who lived there, a hotel with two hundred guest rooms and one hundred baths was built in 1870. The Avon Hotel, later the Milner, was the guest home for traveling salesmen. Indeed Grand Avenue was a thriving thoroughfare; its four movie theaters indicated the size of the neighborhood. Bakeries, butcher shops, fish markets, bars, and more than twenty furniture stores lined the Avenue.

Fair Haven had a Post Office and its own fire house on East Pearl Street with over sixty firemen with red and black uniforms. Each Fourth of July, the company celebrated with a clambake. The unification with New Haven brought the building of new schools: Woolsey grade school on Poplar Street, the Lloyd Street School, Ferry Street School and Cheever School, named for Ezekiel Cheever, the first schoolmaster in New Haven. St. Francis R.C. Church held its first service in 1867 and by 1881, the church had been completed along with a school and rectory. Episcopalians built Grace Church at Blatchley and Exchange Streets and the Baptists constructed a church at Grand and Poplar in 1885. Churches seemed to be going up on every corner and not to be outdone, the Congregationalists redesigned their Grand Avenue building in a Romanesque style. Fair Haven activities centered around church, school, or some social society where people gathered to work and have fun.

Along Grand Avenue, a large variety of businesses made their appearance. At the foot of the Grand Avenue Bridge, William Warner opened a hardware store in 1883. Four drugstores could be found mixed in with food stores, a livery and the largest laundry in New England when it opened in 1891. That same year, Smith T. Bradley opened a florist's shop at 133 Grand Avenue; his greenhouses were on his father's land on Atwater Street with its barn that housed its delivery
wagon. The 1870 merger with New Haven prompted businesses and industries to settle and expand in Fair Haven; during the following hundred years, they would arrive and depart, change and renew, and provide jobs for the many new arrivals in the area.

By 1913, the center of Fair Haven would move from the river to the intersection of Grand and Ferry Streets according to the census. The inhabitants were no longer dependent upon or content with oystering as a principal source of economic support. Second and third generation Irish chose government jobs and politics. The Italians chose to work in construction or in the shops and factories. As immigration increased in the 1900s, new schools were needed. Clinton Avenue School's cornerstone was laid in 1911, and Fair Haven Junior High was erected in two stages beginning in 1927. Two Roman Catholic Churches opened, St. Rose's in 1908 and St. Donato's in 1915. Three fire stations existed and a police station was located in 1895 on Grand Avenue. Fair Haven had been transformed from a small community based upon waterfront activity to a busy, vital, and diverse area with a population of 23,960 in 1930.²

THE IMMIGRANTS

"How old are you?" she asked. "I'm thirteen."

He had almost tripped over her sitting on the last step; he was running down the front stairs from his uncle's flat, the rooms in the house on Wolcott Street.

He mumbled and started to walk away. He was on his way to the Chinese hand laundry, Church Lee's on Grand Avenue, to get his uncle's and father's shirts. His mother wanted them picked up before closing, so the men could wear them on Sunday. He had no time for talking . . . especially to this girl.

"Mind if I come along?" she said smartly and fell into step with him. "My name's Cathy McDonald . . . I live across the street. You got a name?"

"Ignore her," he thought, "walk faster." His uncle had warned them about the Irish; they didn't like new people moving into their Fair Haven neighborhood. "'Fraid we're gonna have their jobs," were his uncle's words.

But she didn't quit. "You and your family just got here, huh."

He guessed that this wasn't a question; "What does she want?" he thought and began to walk even faster as he crossed Exchange Street. His family had arrived in New York Harbor only a week ago from Sorrento on the Italian coast. His uncle had met them and took them on the steam train to New Haven. Just a few days ago, he remembered riding along Chapel Street in the wagon loaded
with his father, mother, two sisters, little brother, and all their belongings. He remembered how excited he was . . . new places, big factories, crowds of people, strange words . . . a different world . . . a new home.

They had reached Grand Avenue with its food markets, bakeries, butcher shops, bars, clothing stores; people hurrying home on this late Saturday afternoon. He saw the laundry and quickly headed toward it.

"I'll wait here," she said.

Glad to be free, he went in, handed over the ticket and money, "Maybe there's a back door," he thought. The old Chinaman then gave him a wrapped package and he had to return outside. She was not there . . . gone.

He started to retrace his steps thinking that all the things that his uncle had written in his letters were true. America was fast moving, busy, a growing place; a land of opportunity and if you wanted to work, a promise to all people of becoming wealthy and being free. He was glad that they had left the farm in Italy; he didn't like it and didn't want to farm as his father and grandfather had done. 1902 was going to be a new beginning for him.

Lost in his thoughts, he was startled by the sound of her voice again.

"Way down Grand, my father runs Clerkin and McDonald; it's a plumbing and heating business. They sell stoves, steam heating, and 'sanitary plumbing'—that's indoor bathrooms. He came over to America in 1852 from Newmarket in County Limerick, Ireland," she said proudly. "Came steerage, like you folks probably, all squeezed into the bottom of the boat. His uncle had a place for him here to live. Father worked on the railroads for a while but then started selling stoves; after mother came over, she worked as a maid in Mr. Lancraft's house on Lenox Street across the Quinnipiac River. Anyway, they saved and with Mr. Clerkin opened their business. Got a couple of delivery trucks now."

He wondered if she ever stopped talking.

"Your uncle works at Mr. Wilton's folding box company on James Street; got a good job, my father says."

Her voice was a jumble of sounds to his ears. They had recrossed Exchange Street and turned onto . . . "Wolcott Street was named for the Yale graduate, Oliver Wolcott; he was active in the American Revolution and governor of Connecticut. But that's history," she stated.

They were now in front of his uncle's place. A few more steps and he would be inside, safe.

"You didn't tell me your name," she said and looked him in the eye. "Your name?" she repeated slowly.

He hesitated.
"What's your name . . . n-a-m-e?" she said pointing at him.
"Michael . . . Michael Longobardi," he said as his face blushed a bright red.
"Welcome to Fair Haven, Michael," she said turning to cross the street.

CHANGE AND INDUSTRY

Street names often provide clues to the history of a community; they can serve as a touchstone with the past. Running along Mill River can be found a street by that name so called because of the eight colonial gristmills that existed along the river by 1780. River Street was named for the Quinnipiac River that parallels on the southern edge of Fair Haven. It runs eastward from the site of the 1859 J.M. Wiswell Carriage factory at the end of James Street to the former Gesner and Baldwin shipyard site where the old ferry crossed the river to East Haven. The open land, the harbor and rivers, the existing fishing wharves, and railroad connections, coupled with Yale University's presence, a history of invention, skilled workers, and entrepreneurs, made the New Haven area a natural place for the new industries in the second half of the nineteenth century. Thus, as oystering was peaking and declining, Fair Haven would enter the era of industrialization.

From Bristol, Connecticut, Chauncy Jerome sent his nephew in 1845 to supervise the building of a new clock factory. Five years later, the nephew, Hiram Camp, opened his own company, New Haven Clock. Camp, an inventor, engineer, and businessman, built the company into the world's largest by his death in 1893. His home, an Italian Villa on Ferry Street, had formal gardens and property reaching to Peck Street. During World War I, clock and watch making was suspended in order to make marine and bomb fuses. Two million fuses were produced. With peace time, the expense of retooling and competition, the company could not return to its former profitable levels, and under the control of Swiss watch brokers, it closed. This would be the fate of many Fair Haven industries as the decades passed during the twentieth century. But for many years before, Fair Haven and its community witnessed a remarkable period of great industrial pioneers.

Moving from New Britain, where there was a shortage of workers, Joseph Bradford Sargent with his brothers established their hardware manufacturing business in 1864. They located at Water, Wallace, and Hamilton Streets and housed several hundred workers, whom they had brought with them from New Britain, to the nearby Pavilion Hotel. The company produced tools, safety exit devices, twine holders, letterdrops, hardware of all sorts including cow bells. In 1884, the J.B. Sargent Company began to manufacture locks, and it would
become the largest lock producer in the United States. Its 1894 catalogue showed forty-three pages of padlocks in over 300 styles.  

Near the tip of Fair Haven's peninsula, an area called Grapevine Point, carriage companies could be found before the Civil War on the flat land along River Street. It was here that Hobart Bigelow moved his machine shop in 1869 to land that he bought and set up operations in the abandoned former Civil War barracks of Camp Terry. The company grew and soon needed a three-story brick factory.

The Bigelow Company produced portable engines sent westward to the gold mines and oil fields in Pennsylvania, as well as cutters and milling machines for the sugar cane plantation in the Caribbean. The founder's son, Frank, decided to concentrate on one product after his father's death; the entire plant was given over to making boilers. A new factory covering many acres was built in 1905 and the Bigelow Company would become the largest manufacturer of steam boilers in New England.

National Pipe Bending Company adjacent to the Bigelow Company on River Street was the sole manufacturer of the National Feed Water Heater, an appliance for heating feed water for boilers. Besides the new industries of the later 1800s, Fair Haven still retained some older ones. On Grand Avenue, James McLay, Jr. specialized in business wagons and on Ferry Street could be found a shop producing carriages, wagons, and carts. Scoville and Peck manufactured coach and carriage lamps on Grand Avenue. Old industries and new ones, such as the Strouse-Adler Company and shirt makers, created a greater demand for dry-goods containers. In 1906, the National Folding Box Company moved into its plant at James and Alton Streets near Mill River. The company's new plant covered an entire block. The business had been created by David Wilton of New York, who unified eight small folding box companies and merged with two New Haven ones in 1891. Within fifty years, it had become the world's largest plant devoted completely to the making of folding boxes employing one thousand workers. National Folding Box was bought out by Federal Paper Board Company in 1953, and in 1957 operations closed in Fair Haven as the company moved to Virginia.

Started in 1880 by Adelbert W. Flint to make lawn and porch furniture, the A.W. Flint Company is still in business on lower Chapel Street. Its specialty is a complete line of ladders and scaffolding. Still visible, but now an example of modern adaptive use, found at the corner of Ferry and Front Streets, is a towering brick monastery-like structure; it was the Quinnipiac Brewery in 1892; later called the Yale Brewery, it was a financial success in bottling and brewing beer. Today it has been converted into apartment housing. Another, yet luckier survivor, is the Roland T. Warner Company at the corner of Grand and Front
Streets. Started in 1883 as a hardware store catering to marine trade, it still serves the community.

Special in Fair Haven’s industrial and business history was the world famous A.C. Gilbert Company. Raised in Oregon, Alfred Carlton Gilbert studied medicine at Yale, but with his mechanical genius and a desire to instruct the young Gilbert first turned to a career in magic. Married and living in Westville, he began to manufacture boxes of magic tricks. The Mystro Manufacturing Company soon was so successful that Gilbert bought an old carriage factory in New Haven. A natural athlete, who had won a gold Olympic medal in 1908 for pole-vaulting, he merged energy with an inventive mind. While traveling to New York, he observed the steel girders being erected to carry power lines; the idea occurred to him that young boys would like to build such things on a smaller scale. In 1913, his first Erector Sets were displayed at the New York Toy Fair and were a success.

The following year, Gilbert bought a piece of land on Fox Street in Fair Haven and built a factory to make the Erector Sets. The educational toys ranged in cost from a dollar up to twenty-five with small electric motors available. Business soared, and a larger plant was needed; so the A.C. Gilbert Company moved into the former Maxim Munitions Works at Blatchley and Peck Streets. To make year round employment, Gilbert began to manufacture rotary fans. Of his 150 patents, his most important contribution to the industry was enameled wire for small electric motors. Gilbert expanded his business to produce chemistry sets, radio sets, electrical toys, and later in 1938 bought the rights to manufacture American Flyer trains. The factory employed thousands of Fair Haveners, many of whom worked at home doing piece work, like assembling set screws on Erector gears and pulleys.

In 1920, radio station WCJ began transmitting from Erector Square. Gilbert himself did a sports review which was the first such program on radio and also interviewed sports personalities of the day. A.C. Gilbert was a self-made and many-sided man. He enjoyed big game hunting and photography; he was a leader in business and community life as well as an inventor and a salesman.

During World War II, the toy manufacturing company adapted by producing parachutes, flares, and small motors for fighter planes. The company made ninety percent of all the firing devices used by the Allies in land mines, anti-personnel devices, and explosives used in sabotage. After the war, beside the toys, electric drills, portable mixers, and hair dryers, microscopic kits and atomic Geiger counters were produced at A.C. Gilbert’s. The company at one time was the world’s largest toy manufacturer and once again had made Fair Haven
famous. Unfortunately after A.C. Gilbert's death in 1961, the company disintegrated and the Blatchley Avenue factory closed in 1967.4

FAIR HAVEN INDUSTRY AND CHANGE

"I remember the days when the trolley cars used to be pulled by horses," Grandpa said for no special reason. I looked up at him from the step of the front porch; he leaned back in his rocking chair and continued. "The two track railroad went along Grand Avenue to Olive Street and then to Chapel . . . You could ride from the Quinnipiac to the Green and on to Westville on Whalley Avenue. Hundreds of horses were stabled in barns near the Grand Avenue bridge. What a smell! The whole ride took over an hour, just to cover the six miles to Westville."

"That was over fifty years ago," my father said as he reached for the lemonade and poured himself another glass. It was red hot this summer evening. There was no breeze, even on the front porch, but the lemonade was cold.

My father looked down at me and said, "They made the trolleys electric in the 1890s when electricity became more available. I remember them putting in electric street lights and people having their homes wired . . . At first, we only had electric service between three in the afternoon and midnight; a lot of people kept their old-fashioned, smelly gas lights. When the U.I. Company opened English station on the Mill River in 1899, service improved."

"Made a mess," Grandpa snorted. "All them wires, hundreds, crisscrossing over Grand Avenue on all them poles . . . telephone lines too . . . ruined the view. And the coal! Barges going and coming with coal for the power plant . . . the smell of the sulfur from the burning coal . . . ruined the air."

"Without burning the coal, they couldn't make the steam that ran the turbines that produces the electricity," my father stated. "That's progress . . . things gotta change."

"Change!" Grandpa almost shouted. "Before that change, Fair Haven used to be a quiet place. Now we got all these factories making smoke and noise, railroads cutting across Fair Haven, trolleys every five minutes, automobiles honking . . . and all kinds of new people. . . ."

"The factories make jobs, Pa . . . the work helps us afford new things," my father replied seriously.

"Job! You call where you work making toys a job?" the old man said.

I looked at my father; I knew he worked at A.C. Gilbert's over on Blatchley near Peck Street. I had thought that he made electric motors.

"Some people at the company make toys," he answered. "That's how Gilbert started. He made magic tricks after graduating from Yale. He was going to be a
doctor, but liked magic and teaching people to think; so he started a business that sold boxes of magic tricks in New Haven. One day while on a train to New York, he saw men putting up steel girders for power lines and got the idea that children also would like to build such things, but it would have to be on a smaller scale. So in 1913, he made the Erector Set . . . strips of metal with lots of holes that could be easily assembled into buildings, machines, trucks, anything that you could imagine with nuts, bolts, pulleys, and wheels which came with the set. They came in different sizes, some having little electric motors. They were sold for a dollar up to twenty-five. Gilbert made lots of money and moved his company to Fair Haven and a bigger factory. Later he bought the right to make American Flyer trains and produced other educational toys such as chemistry and radio sets."

"Toys," Grandpa interrupted. "I told you."

"Not only toys," father continued, "in my section of the factory, we make small electric motors for rotary fans. Gilbert wanted year-round work for his employees, so more things than toys are now produced. Gilbert invented an enamel wire that insulates the wires that get hot. He has over a hundred and fifty different patents. He's quite a genius. From his factory, he started the WCJ radio station; it broadcasted the first sports program in the country . . . right here from Fair Haven. The A.C. Gilbert Company is the world's largest toy manufacturer, but now with another war coming in Europe, we are going to make our electric motors for airplanes . . . and parachutes . . . and firing timers for explosives in anti-tank mines."

Father reached for more lemonade . . . Grandpa stayed silent with his thoughts.

This summer of 1939 had been very warm but exciting for me. New Haven's Tercentenary was going on . . . It was New Haven's three hundredth birthday and people were celebrating with festivals, concerts, parades, and the play at the Yale Bowl, "Through Many Generations—A Pageant of Old New Haven."

And the "Progress Exposition" . . . I remembered seeing so many Fair Haven manufacturers and industries showing their products—Sargent's, the world's largest hardware company; the Bigelow Company with its huge steam boilers; National Pipe Bending; National Folding Box from James Street; the Flint Ladder Company from Chapel Street; and of course, the A.C. Gilbert Company was there showing off its specialty—the toys. I was proud that Fair Haven had such a large part in the history of New Haven.

I wondered, "What progress will I see when I grow up? How will Fair Haven be changed?"

"Time for bed," father said over my thoughts . . . and we left Grandpa with his memories.
THE RECENT PAST AND FUTURE

The industrial age in Fair Haven provided work for the many immigrants that poured into the area. As the older river dwellers before them, these factory workers developed their own sense of belonging to the neighborhood and their own pride in being a Fair Havener. The Irish and Germans had come first between the 1830s and 1850s living in the cheapest housing that was available. Italians began arriving during the closing decades of the 1800s and lived close to the factories that gave them employment. East Europeans followed and settled in the oldest and poorest sections. As time passed, the next generation would move according to their economic means usually farther from the centers of manufacturing. Beginning in the middle of the twentieth century, many third generation families moved into New Haven’s suburbs. Only blacks were an exception to the economic and geographic pattern. As their number increased, the areas in which they lived just spread out in size.

During the 1930s and 1940s, the factories were busy meeting the demands of the war, but thereafter, the economy began to change. The industry that had contributed to Fair Haven’s growth now contributed to its post-war deterioration. The industry moved from urban settings into the suburbs and to rural areas. Fair Haven’s prosperity faded as the factories became empty through relocation or closing; workers moved or remained behind to find work elsewhere outside of Fair Haven. The 1950s began for New Haven and its neighborhoods a flight by whites to the suburbs and an in-migration of blacks and Hispanics. Unfortunately, what had attracted earlier immigrants—jobs—declined during this period from 34,500 manufacturing jobs in 1947 to 14,500 in 1980. What new industries did open were highly automated and required a relatively small number of skilled workers. Job opportunity shifted from manufacturing to such service occupations as health care, finance, real-estate, retail, and government jobs.

From studying Fair Haven, the student can learn that change is constant. Many of the abandoned factories are gone, either torn down or converted to smaller, more diverse uses, such as Gilbert’s Erector Square. Old tenement housing have been replaced with condominiums and single or duplex houses. Preservation efforts and gentrification, especially along the river and main streets, have renewed the visible facade. From nineteenth-century-like street lights and trash containers to architectural renewal, Fair Haven has attempted to recapture its past heritage. New immigrants have arrived and have rekindled a spirit of vitality. Since the 1970s, a new chapter in Fair Haven’s history is being written, titled “restoration.”

Many students in Fair Haven are first or second generation residents and have no concept of their community other than as a place to live. To them, it has no past and may present a bleak future. The students, in a sense, are as much
immigrants to Fair Haven as the late eighteenth century foreign immigrants or southern migrants who sought a new life in this coastal setting. They face the stress of re-settlement and the process of change. They must recognize their responsibility as members of this community to its families, neighbors, environment, and their role in the larger society.

In the first act of the Broadway musical, "Into the Woods," the fairy tale characters are granted their greatest wish as they journey through the woods. The second act reveals how each wish had a significant effect on the well-being of the community. The musical's theme deals with how the individual affects society. Like Cinderella, Jack, or Little Red Riding Hood in the play, students must realize that their lives are a part of a community. They are connected to their community's past and will make an impact on its future. Only with a sense of belonging, can they develop the security which will allow them to grow, contribute, and have a sense of civic pride.

THE COMMUNITY AND YOU: LEARNING YOUR WAY AROUND FAIR HAVEN

The fictional stories are best read orally by the students with the characters assigned as parts including the narrator. In this way, the students become part of the action and may develop a feeling of belonging.

The following classroom activities are designed to help the students visualize Fair Haven; they will become acquainted with its location within New Haven and the surrounding area. The activities provide for practice in geography related skills and may give students a sense of place. The mapping activities may be used after each of the topics in the unit's content, after a fictional story or independently.

Activity I: Fair Haven, 1856

Note: the shape of Fair Haven (define "peninsula"), the railroad lines, open spaces, and the relationship of Fair Haven to the rivers.

Activity II: Fair Haven and New Haven

Note: the advantages of being near the harbor (trade, sailing, and fishing). New Haven as a transportation center (roads, harbor, airport, rivers), the cardinal and
intermediate directions, and reference a road map for finding where Routes 91 and 95 lead.

**Activity III: Fair Haven’s location within New Haven and area cities**

Note: color in water areas blue; trace over broken lines to illustrate boundary locations; print names of the cities on the lines.

**Activity IV: Fair Haven Street Maze**

Note: an exercise in careful reading of directions.

Extended activities may be added to engage students in collecting oral histories of a family or other personal recollections; compiling lists of community institutions, businesses, and professional services; visiting local burial sites. As well, students should be encouraged to use the resources of the local historical society or preservation group. An ongoing activity could be the collecting of local newspaper articles which deal with the community.

Upon completion of these activities, the students should then be exposed to Fair Haven’s and New Haven’s place in Connecticut, the state in the New England region, and so on. Regions are often blends of human and physical characteristics—communities within communities.

**Activity I**

*Fair Haven Map, 1856*

1. Grand Avenue runs in an ____ to ____ direction.
2. Ferry Street runs in a ____ to ____ direction.
3. Exchange Street is ____ (direction) from Grand Avenue.
4. Along the Quinnipiac River, most of the streets are on the ____ (direction) side.
5. What street runs parallel to the Quinnipiac River?
6. Put an “X” where the school should be located.
7. Shade in an island on the map.
8. Put an “T” where the railroads intersect.
9. Outline a peninsula on the map.
10. Put an “H” where your house is located and draw on your route to school.
Fair Haven 1856

(1856 map drawn with modifications from New Haven county map, published by H. & C. T. Smith, Philadelphia.)
Activity II: Fair Haven and New Haven

Learning Your Way Around

1. Name the three cities on the map that the Connecticut Turnpike (Route 95) goes through: ___, ___, and ____.
2. Downtown New Haven is shown by ____ squares on the map.
3. New Haven is bordered by what city on the east?
4. New Haven Harbor is part of what larger body of water?
5. Name three rivers that appear on the map: ____, ____ and ____.
6. What is the largest river in New Haven? ____.
7. New Haven Harbor borders New Haven and ____.
8. Grand Avenue crosses two rivers, the ____ and ____.
9. The city of Hamden is located ____ (direction) of New Haven.
10. Route 91 goes in a ____ direction after ____ crossing the Mill River.
11. The airport is ____ (direction) from Yale Bowl.
12. East Rock is ____ (direction) from Yale Bowl.
13. The best route to East Rock from downtown New Haven is on ____ Street.
14. Fair Haven is bordered by what two rivers?
15. The fastest route to West Haven from East Haven would be on Route ____.
16. From Ferry Street, the best route to downtown is on ____.
17. From Fair Haven, you would travel along ____ Street to get to the Yale Bowl.
18. Crossing the Ferry Street bridge, you can get to the airport along ____ Avenue.
19. From Fair Haven, you could take ____ Street to get into Hamden.
20. Chapel Street ends at the ____ River.
Fair Haven and New Haven
**Activity III**

*Fair Haven's Location Within New Haven and Area Cities*

Print the city's name on the line.

1. Milford
2. Orange
3. Woodbridge
4. New Haven
5. West Haven
6. Hamden
7. North Haven
8. East Haven
9. Branford
10. Fair Haven

Can you spell the cities' names?
Fair Haven’s Location Within New Haven and Area Cities

1. Name five shoreline cities that appear on the map.
2. New Haven Harbor is part of _____ Sound.
3. What city is west of Branford?
4. What river forms part of the border of two cities?
5. Name the largest river in the area.
6. New Haven is bordered by how many cities?
7. Mill River flows south into New Haven from what city?
8. What direction is the Harbor from Fair Haven?
9. Orange is what direction from West Haven?
10. Fair Haven is what direction from the Quinnipiac River?

Supply the missing letters:

1. ___RAN_O_D
2. WO___B___DGE
3. H_MD_N
4. ___A_R_A_E
5. ___U_N___I_C
Activity IV: Fair Haven Street Maze

Draw your route on the map by following the directions.
1. Start at X and go East on Grand Avenue for 5 blocks.
2. Turn South onto Ferry Street and go 8 blocks.
3. Travel on Wolcott Street for 2 blocks.
4. Go South to River Street, and West to James Street.
5. Turn North for 6 blocks and then East to East Pearl Street.
6. Go North 3 blocks and East to Front Street.
7. Travel North to Pine Street.
8. Go West to the corner of Ferry and one block South to Clay Street.
9. Continue West on Clay to the end, go North 3 blocks and
10. You are on ____ Street.

Find the letters “F” and “H” in the maze and shade them in.
Follow up questions for fictional stories:

**The River and the Oyster**
1. What is this a story about?
   A. State Boarding
   B. Schooners
   C. Change over time
   D. Oystering
2. Which pair of boats were used for oystering?
   A. Canoes and schooners
   B. Sharpies and sloops
   C. Sharpies and dugouts
   D. Sharpies and schooners
3. Oysters are?
   A. Found on East Pearl Street
   B. Found on Long Island
   C. Starfish
   D. Shellfish
4. “Spats” are?
   A. Baby oysters
   B. The oyster’s enemy
   C. Nickname for “Sharpies”
   D. A skateboard trick
5. Along Front Street used to be found?
   A. Steam boilers
   B. Oystermen’s houses
   C. The railroad
   D. A park

**The Immigrants**
1. This story takes place
   A. on Sunday afternoon.
   B. on Saturday morning.
   C. in 1902.
   D. in 1852.
2. The word “steerage” means?
   A. Kind of stove
   B. Section of a boat
   C. Place on Fair Haven
   D. Type of factory work
3. Which of the following pairs does not belong?
   A. Italian—Italy
   B. Chinese—China
   C. Irish—Ireland
   D. Fair Haven—Connecticut

4. Choose the best reason why Michael does not talk to Cathy until the end of the story.
   A. Michael probably doesn’t understand much English.
   B. Michael was told not to talk to strangers.
   C. Michael is afraid of girls.
   D. Michael probably is too tired from walking fast.

5. Which of the following is true?
   A. Immigrant families had no relatives in America.
   B. Immigrant families traveled by train to America.
   C. Immigrant families sometimes had a relative living in America.
   D. Immigrant families all came from Europe.

Fair Haven Industry and Change

1. The year of this story is
   A. 1890
   B. 1899
   C. 1913
   D. 1939

2. Which came first in time?
   A. Erector Sets
   B. New Haven’s Tercentenary
   C. Electric trolley cars
   D. American Flyer Trains

3. What is the difference between the Quinnipiac River and the Westville Section of New Haven?
   A. About 1 hour
   B. About 6 miles
   C. Less than 4 miles
   D. Not given

4. Which of the following would not describe A.C. Gilbert?
   A. Inventor
   B. Medical doctor
   C. College graduate
   D. Businessman
5. What is a negative effect of industry?
   A. Makes noise and pollution
   B. Provides jobs
   C. Brings change
   D. Promotes progress

Answers:


Notes

1D.B. Townsend, Fair Haven, pp. 1-66. The historical material is based on this rich narrative of Fair Haven.
2Ibid., pp. 67-126.
3The Completion of Independence in New Haven, pp. 28-29 and 35-37.
4Added insight gained from conversations with Charlton Gilbert (A.C. Gilbert's grandson).

Annotated Bibliography

Note: A general bibliography is provided without division because student readings are limited.

Belmont, Jeff. “East Farms... Fair Haven” and “Oystering Was Big Business.” New Haven Register, June 6, 1975, p. 3B.
Institute. 1984. Overview of historical background and existing architecture including public structures, commercial establishments, and private residences.
Hornstein, Harold. "When Captains Came Home to Fair Haven." *The New Haven Register*. February 24, 1974, 5B.


Shumway, Floyd and Hegel, Richard, eds. *New Haven: An Illustrated History*. Woodland Hills, California: Windsor Publications, 1981. A collection of nine authors' views of New Haven; an overview of its history and various topics are covered. Fair Haven references are limited but a larger history of the city is presented; of interest are industry and social history; beautiful illustrations.


4
The Chronicles of the New World, Shakespeare’s *The Tempest*, and ESOL Instruction

Norine Polio

Caliban:
This island’s mine, by Sycorax my mother
Which thou tak’st from me. When thou cam’st first,
Thou strok’st me, and made much of me; wouldst give me
Water with berries in’t; and teach me how
To name the bigger light, and how the less,
That burn by day and night; and then I lov’d thee,
And show’d thee all the qualities o’ th’ isle,
The fresh springs, brine pits, barren place and fertile:
Curs’d be that I did so! . . .

Miranda:
I . . . took pains to make thee speak, taught thee each hour
One thing or other: when thou didst not, savage,
Know thine own meaning, but wouldst gabble like
A thing most brutish, I endowed thy purposes
With words that made them known . . .

*The Tempest*, Act I, Scene ii (ll. 332-341; 355-359)¹

Shakespeare demonstrates in a few lines the essence of the seemingly endless and controversial debate regarding second-language acquisition. On a positive note, the playwright captures the give and take of cultural exchange, the delight in sharing totally new experiences, in renaming and redefining objects and ideas. But Shakespeare’s genius comes in showing us the dark side, the often patronizing tone, the loss of self which results when the new language is considered by the instructor and/or the population at large to be superior to the native one.

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As an E.S.O.L. (English to Speakers of Other Languages) teacher to 6th, 7th, and 8th grade Hispanic students in the Bilingual Department at Roberto Clemente Middle School and Fellow in the Yale-New Haven Teachers Institute seminar “Writings and Re-Writings of the Discovery and Conquest of America” by Roberto González Echevarría, I find the connections between The Tempest, our readings on the Conquest, and language teaching/learning to be intriguing. Our seminar has explored the major texts which announce, describe, and interpret the Discovery and Conquest of the New World including works by Christopher Columbus, Hernán Cortés, Bernal Díaz del Castillo, Cabeza de Vaca, Bartolomé de las Casas, Michel de Montaigne, Garcilaso de la Vega el Inca, Roberto Fernández Retamar, and the anonymous native writers included in the volume The Broken Spears.

The attempts by totally different peoples to communicate is, I feel, one of the major themes of The Tempest, making its connection to second language acquisition relevant. While reading the various accounts of the Conquest, I have written endless notes in the margins regarding communication between conqueror and conquered including references to interpreters, translation, signs and other non-verbal expressions, native languages and dialects, and definitions of terms. These elements in the chronicles coupled with themes in The Tempest to which Caribbean-born Hispanic students can relate— island life, storms, shipwrecks, magic—are the structure upon which this unit is based. References to the historical works will be included when they parallel the particular scenes extracted from The Tempest in order to illustrate the similarities between the chronicles and Shakespeare's work. Since the historical documents are easily available in Spanish, teachers might consider having students literate in Spanish read these in the original to facilitate comprehension. Obviously some of the references are not within students' grasp; they are included however if the teacher wishes to paraphrase what I consider relevant background material for critical analysis.

In the transitional Bilingual classroom there is a delicate balance, when teaching English, between imparting communication skills in the new language and encouraging students to express pride in their native tongue through speaking, reading, and writing. This curriculum unit has been designed to promote critical thinking by posing the following questions related to the point-of-contact between cultures. Students and teachers alike may analyze the similarities and differences between the dynamics of the teacher/learner in The Tempest and their own educational experiences:

- What do you think happened between Caliban and the Europeans, Prospero and Miranda, when, according to them, he was first instructed to speak?
- Had Caliban and his mother, Sycorax, communicated with each other during the 12 years they lived together before she was banished?
- Does Miranda consider Caliban's sounds "gabble" (Act I, Scene ii, l. 357) because she doesn't understand them?
- Might Caliban think that Prospero's and Miranda's utterances are gabble?
- When you are first exposed to a new language, does it sound like gabble?
- Does it sound like gabble after you are exposed to it over a period of time?
- How might The Tempest have been different if Prospero and Miranda had recognized Caliban's utterances as a valid system of communication and had attempted to learn his language as he had learned theirs?
- How do you think Caliban would have felt about this?
- Should the direction of language instruction be one-way only, from teacher to student, or can students impart knowledge to teachers?
- What happens to Caliban's native tongue now that he has no opportunity to use it?
- How do you think Caliban feels about this?
- What would happen to your native language if you had no chance to use it?
- How would you feel about this?

Suggestions for lesson plans, class discussions, and homework assignments are included in the unit. Activities include films and poetry in addition to map skills, theater games and oral exercises. There is also an emphasis on isolating the technical dramatic elements found in the text. This concentration on costumes, sound, lighting, and scenery encourages students to focus on the play from the point of view of the stage technician.

It is obvious that reading The Tempest in its entirety is a very sophisticated task for even the average native English-speaking student and for this reason only relatively simple passages will be cited. An appreciation for Shakespeare often requires years of careful cultivation and begins by elemental familiarization with the sounds of the words, even if the meanings are obscured. I believe there is an advantage with beginning English speakers in that students are not yet aware of the unfamiliar words and awkward sentence construction with which many native speakers are uncomfortable almost immediately.

Since the level of English skills is relatively low for transitional students who have had 2-4 years of E.S.O.L. instruction, I would suggest introducing The Tempest by recounting the play first in narrative form, using a guide such as Charles and Mary Lamb's Tales from Shakespeare, specifically tailored and illustrated for children. This synopsis could be followed by viewing the British
Broadcasting Corporation’s film, *The Tempest. Forbidden Planet*, a 1950s science fiction version of *The Tempest* with Walter Pidgeon and Ann Francis, might be an interesting and enjoyable comparison for students. However, before familiarizing themselves with the films, the book illustrations, or even the book cover to the Arden edition, I feel it is important for students to formulate their own concepts, particularly with regard to the depiction of Caliban. Teachers can introduce this character as someone who looks and speaks differently from society as a whole and then ask the class to speculate on his appearance and personality. Since these particular students have had personal experiences dealing with an unfamiliar culture they will probably be able to relate to the problem posed by Shakespeare. Students might then begin to understand Caliban’s monster-like depiction in the eyes of the Europeans as a possible exaggeration of the truth since he does not fit into their particular mold, and to analyze judgments placed upon people in contemporary society under similar circumstances.

After students have listened to a narrative version of *The Tempest* and/or viewed the films, they could then be introduced to the possible historical basis of the story. It would be helpful at this point to make maps available to compare the world at the time of the Conquest to the present. (The December 1977 *National Geographic* “Colonization and Trade in the New World”. ) Milan, Naples, and Bermuda could be clearly labelled to familiarize the class with locations mentioned in the play.

Shakespeare’s story is believed to have been based on the separation during a storm of one of nine ships in a fleet which left England in 1609 with John Smith’s Virginia colony as its destination. The colonists were marooned on an island and arrived in Virginia a year later after word of the wreck and possible demise of the colonists had reached England. Scholars believe that Shakespeare was familiar with these accounts as he was personally acquainted with members of the Virginia Company.

A brief analysis of the title of the play might follow (a more detailed treatment follows in Act I, Scene i). Certainly teachers who have come into contact with Hispanic children newly arrived from the Caribbean are familiar with their detailed accounts of personal experiences with hurricanes. Students could be encouraged to relate these impressions, either orally or in written form, thus appreciating the relevance of the play to their own lives.

While becoming familiar with the list of characters, students can make another obvious connection between themselves and Shakespeare’s choice of Latin-based names. Prospero labels the island’s inhabitant “Caliban”, derived from the word “Carib”, the native group believed by some to have ritually eaten
human flesh ("cannibal"). Students can be asked at this point to consider what this character’s real name might have been and how they themselves feel when labelled with an uncomplimentary nickname. The origin of the name Caliban could be illustrated by reading the following account by Christopher Columbus in his journal. On Sunday, November 4, 1492, less than a month after he arrived in the New World, the following entry appears:

He learned also that far from the place there were men with one eye and others with dogs’ muzzles who ate human beings.²

And on November 23, this account:

. . . On it (Haiti) lived people who had only one eye and others called cannibals, of whom they seemed to be very afraid.³

A contemporary response to Columbus’ account comes in an essay by Roberto Fernández Retamar in which he states:

The colonizer’s version explains to us that owing to his irremediable bestiality, there was no alternative to the extermination of the Carib . . . and in Shakespeare, Caliban is a savage and deformed slave who cannot be degraded enough . . . As for the concrete man, present him in the guise of an animal, rob him of his land, enslave him so as to live from his toil, and at the right moment, exterminate him; this latter, of course, only as long as there was someone who could be depended on to perform the arduous tasks in his stead.⁴

Another reference to the barbaric connotation associated with the name Caliban comes in Montaigne’s essay “On Cannibals” which appeared in 1580 and was one of the most widely disseminated European Utopian works. Giovanni Florio’s English translation of the essays was published in 1603. Not only was Florio a personal friend of Shakespeare, but the copy of the translation that Shakespeare owned and annotated is still preserved and is considered one of the inspirations behind The Tempest. Montaigne states:

. . . there is nothing barbaric or savage in these nations . . . what happens is that everyone calls what is foreign to his own customs ‘barbarian’.⁵

Students can respond to the above quotes by supplying their own impressions to unfamiliar people or experiences. Or, if they are comfortable enough with the teacher and fellow classmates, they might relate personal feelings associated with conflicting cultural values when they are considered “foreign” by the society at large in their new environment.
ACT I, SCENE i

Since the primary means of creating the illusion of action on shipboard in Shakespeare's work was suggestive noise and terminology, before showing students Shakespeare's initial stage directions—

(On a ship at sea): a tempestuous noise of thunder and lightning heard (ll. 1-2)

the teacher might elicit words or phrases to create this dramatic atmosphere. Classroom lights could be flashed rapidly on and off to simulate a storm, and then in darkness and with their eyes closed, students might begin to imagine the sounds, smells, sights, and feelings associated with the hurricanes they have experienced. The teacher could write these impressions on the blackboard, thus providing students with a rich vocabulary, and continue by reading the following passages from the chronicles. The first is an account by Cabeza de Vaca who explored Florida, northern Mexico and what is now the American Southwest in the years 1527-1537:

An hour after I left, the sea began to rise ominously and the north wind blow so violently that the two boats would not have dared come near land... All hands labored severely under a heavy fall of water that entire day and until dark on Sunday. By then the rain and the tempest had stepped up until there was as much agitation in the town as at sea. All the houses and churches came down. We had to walk seven or eight together, locking arms, to keep from being blown away.  

The second is considered to be an exaggeration of the truth and is known as the "Myth of the Lost Pilot". It was used to disclaim Columbus' contention of having been the first European to set foot in the New World since the power and financial rewards he would personally reap would minimize the control of the Spanish crown:

... a pilot... called Alonso Sánchez de Huelva... had a small ship with which he traded by sea and used to carry wares from Spain to the Canaries... while pursuing this trade... he ran into a squall so heavy and tempestuous that he could not withstand it... The crew suffered great hardships in the storm for they could neither eat nor sleep. After this lengthy period the wind fell and they found themselves near an island. It is not known for sure which it was, but it is suspected that it was the one now called Santo Domingo.  

The last two quotations are taken from an account of the Conquest by the Aztecs themselves. Broken Spears is a collection of native New World reactions to the events they witnessed first hand. Here we see hints of Prospero's command to Ariel to unleash the tempest:
Motecuhzoma had sent the magicians to learn what sort of people the strangers might be, but they were also to see if they could work some charm against them or do them some mischief. They might be able to direct a harmful wind against them . . . The magicians carried out their mission against the Spaniards, but they failed completely. They could not harm them in any way.  

Students can now read lines 1-17, 34-50, and 58-66 from *The Tempest* in order to dramatize Shakespeare’s expertise in depicting the terror of the storm to those aboard ship. Throughout this approach to the play, if the words or concepts seem too difficult for students, the teacher can isolate one line at a time and the individual character or the class as a whole can respond by patterning their oral response after the teacher’s. If the instructor delivers the words correctly in terms of pitch and tone, students should get a sense of what is being said, even if each word is not fully understood. Students could then be asked to paraphrase, with the teacher’s assistance, in order to test for comprehension.  

**ACT I, SCENE ii**  

The setting is now the island on which Caliban, Sycorax his mother (now banished), and Ariel had been living before Prospero and Miranda’s arrival twelve years earlier (Miranda is now fifteen years old). Creating the mood for this scene might take the form of a class discussion or written assignment pertaining to the differences between island and mainland living, since Hispanic students will have had personal experiences with both. Before reading the section referring to Gonzalo’s having gathered the necessary provisions for Prospero and Miranda upon their flight from Italy—  

Some food we had, and some fresh water, that  
A noble Neapolitan, Gonzalo,  
Out of his charity, who being then appointed  
Master of this design, did give us, with  
Rich garments, linens, stuffs and necessaries . . .  

(ll. 160-167)  

—students can imagine themselves in a similar situation in that specific time period and consider what manageable personal items they would have hurriedly thrown together for such an unexpected departure. My most cherished memories of grammar school revolve around the following exercise related to geography lessons. Our teacher would announce that we would be “traveling”
the next day to a specific part of the world and after telling us a bit about its location and climate, assign us the task of "packing a suitcase"—i.e. cutting out pictures from magazines of whatever we felt was necessary for the trip—and the next day we'd be strapped into our "seatbelts" on our "airplane," "passports" in hand, and be off! Photocopied pictures from historical costume books would be helpful here for the clothing they might carry. Regarding the characters' departure from Italy in The Tempest, students should consider that this might be a permanent situation and that Prospero does not use his magical powers until they reach the island. This should inspire students to select items carefully and to anticipate the problems the characters might encounter on their journey.

When Prospero reaches the island he is "rapt in secret studies" (ll. 75-76) with the books Gonzalo has supplied:

*Prospero:*

_from mine own library with volumes that_  
_I prize above my dukedom._

(ll. 167-168)

Students might enjoy creating booklets with magical symbols and secret codes to help them imagine the power that Prospero reaps from there documents.

Scene ii contains a poignant interchange between father and daughter in which Prospero finally explains to Miranda the circumstances surrounding their present existence. Lines 15-25 and 33-46 serve to give the class a clearer understanding of the characters' plight; the following lines are particularly vivid and would probably leave a lasting impression on students of the hardships Prospero and Miranda faced:

... they prepared  
a rotten carcass of a butt not rigg'd  
Nor tackle, sail, nor mast; the very rats  
Instinctively have quit it...

(ll. 145-150)

Miranda's first memories of her childhood are hazy when Prospero asks her in line 49, "What seest thou else in the dark backward and abyss of time?" Students and teachers alike could be encouraged to think back carefully to their earliest memories in order to recount them either orally or in written form.
Prospero tells Miranda that he has released the tempest through Ariel's intervention and with the magical powers of his robe. He asks Miranda to "pluck my magic garment from me" (l. 24) when he no longer needs control, and students might begin to envision the qualities of this article of clothing by producing a costume sketch. A collection of fabric scraps, especially glitzy ones, would help spark their creativity. Students can attach small fabric swatches along the bottom and sides of the drawing, as is the practice of professional costume designers, in order to suggest color and texture.

Lines 226-237 provide the only specific reference to Bermuda in the entire play and students could read the historical reference to the Bermuda Pamphlets described at the beginning of this unit.

Prospero, in his dialogue with Miranda, recounts their initial encounter with Caliban twelve years earlier. This, to me, is the first reference in the play related to second language acquisition and communication between two cultures, and for this reason I feel it warrants a detailed analysis. The first image we have of Caliban is Prospero's description:

... A freckled whelp hag born—not honour'd
with a human shape... Dull thing, I say so...

(ll. 282-284)

We see the encounter from Caliban's perspective in the lines quoted at the beginning of the unit (l.332-341; 355-359) and it would be an opportunity now to review these and their meaning with the students. This quote, in conjunction with lines 310-315 in which Prospero extols the virtues of Caliban's native intelligence and hard work, provides a basis for discussion of the necessary components for survival in the wild. The foreigners are dependent upon Caliban for their livelihood, yet subjugate and enslave him:

We cannot miss him; he does make our fire
Fetch in our wood, and serves in offices
That profit us...

(ll.311-315)

There is an interesting parallel in Cortes' letter to the king regarding the natives living near Tascalteca:

In a letter of mine I informed Your Majesty how the natives of these parts are of much greater intelligence than those of other islands... indeed they appeared to us to possess such understanding as is sufficient for an ordinary citizen to conduct himself in a civilized country. It seemed to me therefore,
a serious matter at this time to compel them to serve the Spaniards as the natives of the other islands do; yet if this were not done, the conquerors and settlers of these parts would not be able to maintain themselves.\textsuperscript{9}

We have read Columbus' account of rumored cannibals in the area. Here is the entry regarding his initial attempts to communicate with the natives:

On my arrival at that sea, I had taken some Indians by force from the first island that I came to, in order that they might learn our language, and communicate to us what they knew respecting the country . . . in a short time, either by gesture and signs, or by words, we were enabled to understand each other.\textsuperscript{10}

The class could be divided into two groups at this point—natives and conquerors. Having prepared a list of the qualities of their island, the natives, through "gestures and signs" could attempt to communicate these to the foreigners.

The illustrations contained in this curriculum unit are by two students at Betsy Ross Arts Magnet School, Gabriel Arvelo, a 6th grader, and Joel Johnstone, an 8th grader. These are based on adaptations of original codices paintings by Alberto Beltran in *The Broken Spears*. This first drawing and excerpt from the text are included here to draw parallels to *The Tempest* and to imagine Caliban's initial reaction to the Europeans:

\begin{center}
\includegraphics{drawing.png}
\end{center}

Drawing by Gabriel Arvelo\textsuperscript{11}

An emissary had been sent by Montezuma to validate reports that natives had seen "two towers or small mountains floating on the waves of the sea"\textsuperscript{12} and the following is their eyewitness account:

"Our lord and king, it is true that strange people have come to the shores of the great sea . . . There were about fifteen of these people, some with blue jackets, others with black or green, and still others with jackets of a soiled color, very
ugly, like our ichtilmatli . . . they have very light skin, much lighter than ours. They all have long beards, and their hair comes only to their ears.” Montezuma was downcast when he heard this report, and did not speak a word.\textsuperscript{13}

Since these particular students have had the experience in their lives of encountering a culture and language different from their own, the following suggestion for a theater game might help them to recall that initial point-of-contact and the inevitable frustration and misunderstanding which result. Some Hispanic students are well versed in “jerigonza” in which words are divided into syllables and each syllable prefaced with the same sound, for example “chi”. This new language is spoken rapidly and I am totally baffled whenever I hear it! If a student with this skill (pretending not to understand English or Spanish) were to confront the teacher or another student with no knowledge of jerigonza, this might simulate the initial encounter between Caliban and the foreigners. The class could formulate questions which might naturally develop from this situation and help the two actors consider non-verbal methods of communication.

The following quotes from the chronicles pertain to communication between two cultures, further emphasizing the historical antecedents and their relevance. Students can be encouraged to reenact these three situations in the “jeringoza” theater game described above. The first quote from Garcilaso de la Vega el Inca recounts the story of an Indian named Beru who encountered the Spaniards on the banks of the river Pehu:

The Spaniards asked him by signs and words what land it was and what it was called. The Indian understood that they were asking him something from the gestures and grimaces they were making with hands and face, as if they were addressing a dumb man, but he did not understand what they were asking, so he told them what he thought they wanted to know. The Christians understood what they wanted to understand . . . and from that time they called that rich and great empire Peru, corrupting both words, as the Spaniards corrupt almost all the words they take from the Indian language . . . \textsuperscript{14}

Students and teachers alike have probably experienced similar misunderstandings in communication and it might be insightful here to discuss some of these twisted interpretations.

The next two quotes are taken from Cabeza de Vaca’s account:

The Indians of the village returned next day and approached us. Because we had no interpreter, we could only make out what they said; but their many signs and threats left little doubt that they were bidding us to go.\textsuperscript{15}
Students can contemplate what might have been said and attempt to communicate their thoughts non-verbally or through the “jerigonza” exercise above.

And we taught all the people by signs, which they understood, that in Heaven was a Man called God, who had created the heavens and earth; that all good came from Him and that we worshipped and obeyed Him and called Him our Lord; and that if they would do the same, all would be well with them. They apprehended us so readily that if we had had enough command of their language to make ourselves perfectly understood, we would have left them all Christians.¹⁶

A conflicting report is mentioned in Robert Ricard’s book, *The Spiritual Conquest of Mexico*, as he describes the attempts of Munoz Camargo and other clerics to instruct the natives in Christianity:

... the religious could only indicate the existence of heaven and hell. To suggest hell they pointed to the earth, fire, toads and snakes. Then they raised their eyes, pointed to heaven and spoke of a single God. The Indians barely understood.¹⁷

Many Hispanic students are familiar with the beliefs of the Afro-Caribbean “Santería” religious cult. Assuming that the teacher is not and by using only signs and “jerigonza”, students could attempt to “convert” the teacher into this belief system and decide at the end of the exercise if their communication was successful.

Ariel’s song to Fernando (l. 399–405) in which he falsely implies to the prince that his father, Alonso, has died in the shipwreck, is an opportunity for those students interested in music to explore the technical possibilities within the play. The piece is included in the Arden edition and a simple flute recording with the assistance of the music teacher would add a nice touch here. (On page opposite)¹⁸

In addition, students interested in scenic art could sketch their interpretation of these lines. Students are provided with two additional challenges to their creativity by considering solutions to the following stage directions included in this scene:

re-enter Ariel like a water nymph

(l. 317)

re-enter Ariel invisible, playing and singing

(l. 377)
The scene ends (l. 413-470) with Miranda’s first glimpse of Fernando under the careful supervision of her father, who, as powerful as he is, cannot control their mutual attraction. Miranda challenges her father’s negative response to Fernando and what ensues is the age-old generational conflict to which students can easily relate:

**Miranda:**

...I might call him (Fernando)
A thing divine; for nothing natural I ever saw so noble.

(ll. 419-421)
Prospero:
  . . . At the first sight
  They have chang’d eyes . . .

(ll. 443-444)

Miranda:
  . . . This
  Is the third man that e’er I saw . . .

(ll. 447-448)

Fernando:
  O, if a virgin,
  And your affection not gone forth,
  I’ll make you The Queen of Naples.

(ll. 450-452)

Prospero:
  . . . Come;
  I’ll manacle thy neck and feet together,
  Sea-water shalt thou drink . . .

(ll. 463-464)

Miranda:
  O dear father,
  Make not too rash a trial of him, for
  He’s gentle, and not fearful.

(ll. 468-470)

Students can note here the change in tone of the supposedly cultured Prospero.

ACT II, SCENE i

The act opens on another part of the island in which the remaining members of the fleet have been marooned. Lines 45-53 are a comical interchange between four of the characters concerning their impressions, both positive and negative, of the island. The following entry describing Cuba from Columbus’ journal might be discussed here:

This said island of Juana is exceedingly fertile . . . it is surrounded by many bays . . . surpassing any that I have ever seen; numerous large and healthful
rivers intersect it, and it also contains many very lofty mountains . . . all these islands are very beautiful . . . they are filled with a great variety of trees of immense height . . . some of them were blossoming, some bearing fruit . . . The nightingale and various birds were singing in countless numbers, and that in November, the month in which I arrived there. There are . . . seven or eight kinds of palm trees . . .

Students could be asked to draw these different varieties of palm trees from memory and also to compare the flora and fauna of Puerto Rico with the mainland. A dialogue might be improvised in which one actor paints a favorable picture of the new environment while another gives an unfavorable one.

The scene has several costume references (l. 59, 66, 93, 266), and the following illustrations can be analyzed, paying particular attention to the depiction of the Spaniards. From the point of view of the costume designer, students might consider the alterations the characters would make to their garments now that weather conditions have probably changed from those in Italy:

![Drawing by Gabriel Arvelo](image)

Lines 143–151 describe Gonzalo’s idea of a Utopian life style on the island and the pronouncements he would make if he were king. Students can consider their own suggestions for an ideal world and come up with a personal list.

Shakespeare gives us several references (between lines 180-320) to dream-like spells experienced by some of the characters. Students might search this section independently to list these phrases. In their reading (l. 295-300) they will
once again happen upon Ariel working his magic through song as he attempts to awaken Gonzalo from slumber. There is no musical notation available for this particular piece, thus providing interested students the opportunity to develop their own accompaniment which best corresponds to the sense of the words.

**ACT II, SCENE ii**

The act begins with the technical note, "A noise of thunder heard," (I. 1.) followed by a passage by Trinculo in which he vividly describes the storm (ll. 18-
24). A modified version of the exercises suggested at the beginning of the analysis of the play to simulate hurricane conditions could be used now to draw students into the mood of the scene.

The continuation of Trincolo’s discourse on the brewing storm and its relationship to the historical references in the chronicles can be considered here. Trincolo describes his first encounter with Caliban and immediately considers capitalizing on his “otherness” in the same manner chosen by Pedro Serrano, the shipwrecked Spaniard vividly described by Garcilaso de la Vega el Inca in his Commentaries. Serrano’s plight, having spent seven years on a desolate island, is worth reading here for the pure theatricality of this adventure story. The following excerpt from this chronicle (three years into his dilemma another shipwrecked Spaniard joins Serrano, and four years later they are rescued by a passing ship) might prove insightful. Students can consider that Caliban’s “monstrous” appearance was probably a natural adaptive reaction to his environment:

Owing to the harshness of the climate hair grew all over his body till it was like an animal’s pelt . . . His hair and beard fell below his waist . . . Pedro Serrano and his companion, who had grown a similar pelt, seeing the boat approach, fell to saying that Credo . . . so that the sailors should not think they were demons and flee from them . . . They no longer looked like human beings . . . Pedro Serrano reached here (Spain) and went on to Germany where the emperor then was . . . In every village he passed through on the way he earned much money whenever he chose to exhibit himself.²¹

The second quote from The Tempest parallels Garcilaso’s account as Stefano plans to capitalize on Caliban’s “otherness”:

**Trincolo:**

What have we here? a man or a fish? . . . Were I in England now, and had but this fish painted, not a holiday fool there but would give a piece of silver; there would this monster make a man; when they will not give a doit to relieve a lame beggar, they will lay out ten to see a dead Indian . . .

(II. 25-34)

**Stephano:**

If I can recover him and keep him tame and get to Naples with him, he’s a present for any emperor that ever trod on neat’s leather (cowhide).

(II. 67-70)
Students will probably have many stories to tell of their experiences with circus "freak" shows, movies and television programs in response to the above quotes. They might want to consider themselves in a similar situation and explore the deeper feelings of "the other" in order to see it from a different perspective.

This act also contains a reference to the native belief that the Spaniards were an incarnation of the gods of their legends. The first quote refers to Columbus' perception of the people in present-day Santo Domingo and the second is Stephano's response to Caliban's curiosity:

... They practice no kind of idolatry, but have a firm belief that all strength and power, and indeed all good things, are in heaven, and that I had descended from thence with these ships and sailors...  

*Caliban:*  
Hast thou not dropp'd from heaven?  

*Stephano:*  
Out o' the moon, I do assure thec.  
I was the man i' th' moon when time was.  

*Caliban:*  
I have seen thec in her and I do adore thee...

(ll. 135-140)

The end of Scene ii finds Caliban, under the influence of the wine that has been forced upon him by Stephano and Trinculo, deciding to change allegiance and to take them, instead of Prospero, for his masters. Caliban sadly mistakes for freedom what is actually just another form of servitude and slavery. The dialogue which proceeds from line 148 until the end of the scene again graphically depicts Caliban's innate knowledge of natural lore and his willingness to share this with the very people who enslave him. The following lines are particularly graphic:

*Caliban:*  
I'll show thee the best springs; I'll pluck thee berries, I'll fish for thee and get thee wood enough.  

(ll. 160-162)

*Caliban:*  
... let me bring thee where crabs grow;  
And I with my long nails will dig thee pig nuts;  
Show thee a jay's nest and instruct thee how  
To snare the nimble marmoset [monkey];
I'll bring thee  
To clustering filberts and sometimes I'll get thee  
Young scamels [a type of shellfish]  
from the rock

(ll. 168-172)

Since many of the students who make up the bilingual population in New Haven come from the rural areas of the Caribbean, they might enjoy comparing and contrasting their knowledge of the natural wonders of island life with Caliban's.

ACT III, SCENE i

The love between Fernando and Miranda is expressed verbally in this short scene. Since most of the language is very sophisticated, these relatively simple lines (ll. 6-9, 20-21, 31-36, 45-51, 58-60, 63-65, 67-68, 72-74, 83, 86-92), can be excerpted in order to provide the framework for the following comprehension questions:

- How does Fernando describe Prospero?  
- Why is Prospero acting like this?  
- Where is Prospero during this scene? How long will he be away?  
- What is Fernando doing?  
- How does he seem to Miranda?  
- Why isn't he exhausted by his heavy work?  
- How many women has he seen? Men?  
- What does Fernando claim to be?  
- What is Fernando's response when Miranda asks him if he loves her?  
- Why does Miranda cry?  
- Who proposes marriage? What is said?

ACT III, SCENE ii

This scene takes place on another part of the island as Caliban, Stephano and Trinculo plot to kill Prospero, with Ariel in the background trying to undermine their intentions. The language of lines 40-111 is basically simple, and students could mimic the teacher's delivery. The following questions might be posed:

- How does Caliban describe Prospero?  
- What is Stephano's threat to Trinculo?
- What does Caliban intend to do to Prospero when he leads his two companions to him?
- What is Ariel’s role in this scene?
- Who is really starting trouble here? Why?
- What is the first thing Caliban says they must do to Prospero?
- Who is the only other woman Caliban has ever seen?
- What does Stephano intend to do with Miranda after Prospero has been killed?

ACT III, SCENE iii

This scene provides a wealth of opportunities for students interested in technical theater as the storm wells up again and a banquet strangely disappears. In addition to scenic, costume, lighting and properties notes, there are references to music and choreography and to the elements of Ariel’s magic. Students could divide the following stage directions into their corresponding components and decide as technicians in their particular fields what the best solutions would be. They might also consider the differences between a staged and a film version in order to compare the possibilities and limitations of both media:

Solemn and strange music, and Prospero on the top (invisible). Enter several strange Shapes, bringing in a banquet; and dance about it with gentle actions of salutations; and inviting the king and company to eat, they depart.

(ll. 16-21)

Thunder and lightning. Enter Ariel like a Harpy; claps his wings upon the table; and, with a quaint device, the banquet vanishes.

(ll. 51-54)

Ariel vanishes in thunder; then, to soft music, enter the Shapes again, and dance, with mocks and mows, and carrying out the table.

(ll. 82-85)

This scene also contains a description of the islanders by Gonzalo which parallels an entry in Bartolomé de las Casas, and students might consider the similarities in both accounts as a basis for a class discussion and/or a written assignment. Regarding the natives of Hispaniola (Santo Domingo), las Casas states:
... these people are the most guileless, the most devoid of wickedness ... They are by nature the most humble, patient, and peaceable, holding no grudges ... neither excitable nor quarrelsome ... The sons of nobles among us, brought up in the enjoyments of life's refinements, are no more delicate than are these Indians ... 23

ACT IV, SCENE i

A wealth of song and poetry characterizes this scene as the element of the masque is introduced. For those students who enjoy poetry, this would be a good opportunity to repeat the lines after the teacher and to discuss the meaning and content of each poem. A memorization homework assignment might follow. These verses include Ariel's poem (ll. 42-47), Juno's song describing her marriage blessing (ll. 105-110), Ceres' hopes for the bestowal of rich harvests (ll. 111-116), and Iris' call to the nymphs (ll. 127-138).

There are several references to clothing here, presenting yet another chance for students to analyze the play from the costumer's perspective and sketch the corresponding designs. These include the following:

- Enter certain Reapers, properly habited
  (l. 138)

-(re)enter Ariel, laden with glistening apparel
  (l. 192)

- Enter Caliban, Stephano, and Trinculo, all wet
  (l. 194)

Trinculo:
  O, King Stephano!
  ... look what a wardrobe here is for thee!
  (ll. 222-223)

Stephano:
  Put off that gown, Trinculo; by this hand
  I'll have that gown.
  (l. 228)
ACT V, SCENE i

This, the last act in the play, illustrates Prospero's humanity in pardoning his brother and his skill at restoring his lost power. Fernando and his father are reunited, Ariel gains his liberty, having successfully carried out Prospero's wishes, and Prospero extends this freedom to Caliban who regrets having subjected himself to Stephano, "this dull fool" (l. 297). Prospero and the foreigners plan their voyage back to Italy, where Fernando and Miranda will wed.

Shakespeare does not give us any indication here of Caliban's response to the foreigners' exodus from the island. Is he happy that they're leaving? Will he miss these people even though he has been subjugated by them? How do students think this new language and worldly knowledge have altered his perceptions? It might be interesting to imagine that Caliban travels back to Italy with the Europeans in the light of the following quote from Montaigne, his account of a native of the New World's visit to Europe:

Three of these people... were at Rouen at the time that the late King Charles the Ninth was there... and they were shown our fashions, our pomp, and the form of a fair city. After that someone wanted to know what they had found most to be admired... They said... that they had observed that there were among us men crammed with all kinds of good things while their halves were begging at their door, emaciated with hunger and poverty; and that they thought it strange that these needy halves did not take the others by the throat or set fire to their houses.21

Students can observe here several references to the magical qualities of Prospero's robes and to his donning of the garments, including his "hat and rapier," (l. 118) which he wore in Italy, symbolizing his relinquishing of power. The charm is extinguished when he states:

... I'll break my staff
Bury it certain fadoms in the earth,
And deeper than did ever plummet sound I'll
drown my book.

(ll. 54-57)

As an exercise students can dramatize the stage direction which reads:
... they (Alonso, Sebastian, Antonio, Adrian, Francisco) all enter the circle which Prospero had made, and there stand charm’d

(ll. 56-58)

They can then react to Prospero’s statement:

... There stand, for you are spell-stopp’d

(ll. 60-61)

Prospero grants Ariel his much desired liberty and Ariel’s song (ll. 88-93) describes his delight in controlling his life once again. The musical notation is included in the Arden edition, and a class sing-along might follow with simple live or taped accompaniment:25

Encourage students to contemplate what they would enjoy doing if they found themselves in Ariel’s situation, tasting freedom after a long period of sub-
jugation. Their thoughts could be transposed into the text of a song, using the same tune as Ariel's.

**EPILOGUE**

Before showing the script to the class, the teacher could read the Epilogue aloud, omitting the last rhyming word in every other line. Thus students will hear the first clue—the last word of the first line—and will supply the complementary rhyming word at the end of the next line, alternating in this manner throughout the Epilogue. This gives the teacher the chance to test students' comprehension of the play. For example:

Now my charms are all o'erthrown
And what strength I have's mine_______ . . .

As you from crimes would pardon'd be,
Let your indulgence set me______.

Epilogue (ll. 1-2, 19-20)

After the Epilogue has been read, teachers and students can review the major objectives of this curriculum unit to see if they have been met. Do students have an understanding of colonization as portrayed in *The Tempest*? Can they relate the issues associated with one culture being dominated by another to other historical periods? To the present? Can they begin to question history if only one, and not multiple, perspectives are given?

Students will hopefully have seen the parallels between *The Tempest* and the chronicles throughout the reading of the play. Are any of the references to these primary sources vivid enough for students to recount from memory? They have also been trained to look at a play from the point of view of the stage technician—is it easier now to spot costume, lighting, scenery, properties, and sound references?

Lastly, the issue which I find most central, that of language and communication, can best be evaluated by returning to the questions posed at the beginning of the unit related to the point-of-contact between cultures. Hopefully students have become sensitized to Caliban's plight by the end of the play. Students can discuss their initial reactions and any changes they may have felt as the play developed.

In conclusion, this analysis of *The Tempest*, much of it seen from Caliban's perspective, illustrates the complexity of second language acquisition and the sensitivity with which E.S.O.I., instructors in particular approach teaching a new
language while at the same time encouraging pride in the students' native

tongue. With an appreciation for and an understanding of different cultures and

modes of expression, second language teachers will hopefully never be blessed

with Caliban's invective:

You taught me language; and my profit on't
Ils. I know how to curse. The red plague rid you
For learning me your language.

Act I, Scene ii (ll. 365-367)


There have been several changes since this curriculum unit was written. I
taught it for two years to its targeted audience, intermediate and advanced
E.S.O.L. students at Roberto Clemente Middle School, mostly Puerto
Rican, and for the past three years to mainstream (Anglo and Hispanic) 5th
and 8th grade Humanities and Reading classes in my new position as Cur-
riculum/Staff Developer at Betsy Ross Arts Magnet Middle School. The
basic difference between the Hispanic students in both settings is that the
E.S.O.L. students are new arrivals struggling with a new language, and the
mainstream Hispanics range from non-Spanish speakers, i.e., monolingual
English (often both they and their parents were born on the mainland and,
sadly to say, no longer speak Spanish) to true bilinguals, equally at ease in
both English and Spanish—the many stages of Caliban’s language dilemma
right before my eyes, each at a different level of second language acquisi-
tion and first language maintenance or demise. As a result, I believe, of
their personal experiences with second language learning, I found the
Spanish speaking E.S.O.L. and mainstream students to be more sympa-
thetic to Caliban’s plight than their mainstream (Anglo) or mainstream His-
panic (monolingual English) peers. The exceptions were those mainstream
Anglo students who were struggling with either Spanish or French in for-

eign language classes.

Another change is that I have taught the unit to culminate a year-long cur-
riculum based on primary sources (translated into English for those students
who cannot read Spanish) and other materials from the period of the Conquest.
By the last marking period, students have been exposed to both the European
and the Caribbean perspectives and can hopefully understand the conflict in
The Tempest in the context of the broader historical period. My interest in these
writings began in Professor Echevarría’s seminar and I am currently in the
beginning stages of a doctoral dissertation in Bilingual Education at the University of Connecticut. The focus will be the Taino/Arawak peoples, “encountered” by Christopher Columbus and other Europeans in the Caribbean, whose culture virtually disappeared within two generations as a result of the ensuing conflict. The upcoming (1992) Quincentennial and the relative lack of curricular materials based on these indigenous groups make these studies, I feel, a necessity.

Although I continue to use Shakespeare’s original as planned in the unit, I have come across two excellent supplemental versions—an illustrated comic book with student guide and cassette (Pendulum Books), and the script adaptation by Forrest Stone (Classic Theatre for Children). Both are noted in the Bibliography. These can be used in addition to narrative versions, such as the Lamb’s, at the beginning of the unit, to whet students’ appetites. The only problem I have encountered is the typical depiction of Caliban in the comic book—I have literally whitened him out of his monster-like role and have had students draw a more human version. I have also photocopied the drawings of the various characters from the comic book, enlarged them, cut them out and glued them onto cardboard. Tape a chopstick to the back as a handle, and, presto—you’ve got an instant puppet show!

The setting of The Tempest, in my classroom at least, is definitely Caribbean. Although I have never mounted a full-scale production, I have invited other classes in for staged readings of one or two scenes. During some sessions, Caliban has taught the Europeans the traditional ball game (a cross between soccer and volleyball), exposing them for the first time to rubber. We have had Caribbean props for these presentations—root vegetables, tropical fruits, sugar cane from the local Hispanic market, salsa and merengue music and dance during the banquet scene (and prepared Puerto Rican foods which would disappear, as in the play, but which we would feast upon later), rain forest tapes of bird and animal sounds for background noise, classroom lights flashing on and off for the opening tempest/hurricane, mosquito nets and hammocks, Taino/Arawak petroglyphs on the blackboard, and artifacts strewn on the floor—even cigars!

At the recent suggestion of Professor Tom Whitaker at Yale, I have read A Tempest by Aimé Césaire, a contemporary writer from Martinique, and recommend it highly for teachers interested in an alternate interpretation. It is set in an African colony, and with the few expletives deleted, it is certainly within the range of students after they have been exposed to Shakespeare’s work.

For a classroom twist (or as part of a production), Caliban can teach the newcomers his language, thanks to the Taino/Arawak-Spanish-English dictio-
naries that exist (theirs was not a written code, but we have European docu-
m mentation of their language written in our alphabet). The following dictionary
is my version—the illustrations are student adaptations of woodcuts from the
period.

The possibilities, in other words, are endless. The bottom line is to have fun
while you—teacher and student—learn!

Notes

2Christopher Columbus, *Four Voyages to the New World*, R.H. Mahor, ed., p. 20.
4Roberto Fernández Retamar, “Caliban: Notes Towards a Discussion of Culture in
our America,” *The Massachusetts Review*, p. 15.
6Alvar Nuñez Cabeza de Vaca, *Adventures in the Unknown Interior of America*,
Cyclone Covey, ed., p. 28.
7Garcilaso de la Vega el Inca, *Royal Commentaries of the Incas*, p. 12.
8*The Broken Spears*, Miguel Leon-Portilla, ed., p. 34.
10Columbus, p. 9.
14Garcilaso de la Vega el Inca, p. 15.
15Nuñez Cabeza de Vaca, p. 31.
16*Ibid.*, p. 120.
18This song may be found in *The Tempest*, edited by Frank Kermode, p. 157.
19Christopher Columbus, p. 5.
20*The Broken Spears*, pp. 11, 21, 32, 37, 62, 70, 119, 126.
21Garcilaso de la Vega el Inca, pp. 28-30.
22Christopher Columbus, p. 67.
24Michel de Montaigne, p. 88.
25This song may be found in *The Tempest*, edited by Frank Kermode, p. 158.

Annotated Teacher Bibliography

Modern Library, 1953. Questions the basis of European cultures and supports the
natives’ right to self-determination.


**Annotated Student Bibliography**


Díaz de Castillo, Bernal. First hand account of the conquest of the Aztecs in Mexico by one of the last Spanish survivors (1492-1580).

Garcilaso de la Vega el Inca. *Royal Commentaries of the Incas*. Austin: University of Texas Press, 1967. Sixteenth century account by a well-educated mestizo, whose father was a Spanish nobleman and whose mother was related to the ruling family of the Incas in Peru.


### Spanish-Taino-English Dictionary

<table>
<thead>
<tr>
<th>SPANISH</th>
<th>TAINO</th>
<th>ENGLISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agua</td>
<td>Ní</td>
<td>Water</td>
</tr>
<tr>
<td>Algodón</td>
<td>Sorobé</td>
<td>Cotton</td>
</tr>
<tr>
<td>Arribo</td>
<td>Guattao</td>
<td>Friend</td>
</tr>
<tr>
<td>Arroba</td>
<td>Gal Gué</td>
<td>Tree</td>
</tr>
<tr>
<td>Arába venenosa</td>
<td>Guahí</td>
<td>Poisonous spider</td>
</tr>
<tr>
<td>Astuto</td>
<td>Dajo</td>
<td>Seat</td>
</tr>
<tr>
<td>Bolítes de maíz</td>
<td>Guaniriri</td>
<td>Corn biscuits</td>
</tr>
<tr>
<td>Bebida fermentada de casabe</td>
<td>Ukó</td>
<td>Fermented casabe drink</td>
</tr>
<tr>
<td>Bebida fermentada de maíz</td>
<td>Xaxá</td>
<td>Fermented corn drink</td>
</tr>
<tr>
<td>Bueno</td>
<td>Taymo</td>
<td>Good</td>
</tr>
<tr>
<td>Bœque</td>
<td>Jibá</td>
<td>Forest</td>
</tr>
<tr>
<td>Calabaza</td>
<td>Auyarano</td>
<td>Squash gourd</td>
</tr>
<tr>
<td>Carma colgante</td>
<td>Jibó</td>
<td>Hammock</td>
</tr>
<tr>
<td>Casa</td>
<td>Toay</td>
<td>House</td>
</tr>
<tr>
<td>Circó</td>
<td>Jurakán</td>
<td>Sky</td>
</tr>
<tr>
<td>Cigarro</td>
<td>Tabacu</td>
<td>Hurricane</td>
</tr>
<tr>
<td>Cohiba</td>
<td>Guabo</td>
<td>Cigar, Cigarette</td>
</tr>
<tr>
<td>Coche</td>
<td>Guara</td>
<td>Snake</td>
</tr>
<tr>
<td>Coxa</td>
<td>Araguaca</td>
<td>Cave</td>
</tr>
<tr>
<td>Danza</td>
<td>Azeño</td>
<td>Dance</td>
</tr>
<tr>
<td>Danzar cantando</td>
<td></td>
<td>Religious ceremony</td>
</tr>
<tr>
<td>El, ella, ello</td>
<td>Guá</td>
<td>He, she, it</td>
</tr>
<tr>
<td>Embarcación</td>
<td>Canoa</td>
<td>Canoe</td>
</tr>
<tr>
<td>Espíritu benéfico</td>
<td>Yukivu</td>
<td>Good spirit</td>
</tr>
<tr>
<td>Espíritu malediço</td>
<td>Jurakán</td>
<td>Bad spirit, hurricane</td>
</tr>
<tr>
<td>Extrañero</td>
<td>Arúana</td>
<td>Foreigner</td>
</tr>
<tr>
<td>Flor</td>
<td>Aná</td>
<td>Flower</td>
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<tr>
<td>Fuego</td>
<td>Guáguá</td>
<td>Fire</td>
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<tr>
<td>Fruta del guayabo</td>
<td>Guayaba</td>
<td>Guava</td>
</tr>
<tr>
<td>Fruta de la púa</td>
<td>Yayarú</td>
<td>Pineapple</td>
</tr>
<tr>
<td>Fuente de la montaña</td>
<td>Kalishú</td>
<td>Mountain spring</td>
</tr>
<tr>
<td>Guerra</td>
<td>Guasiriba</td>
<td>Way</td>
</tr>
<tr>
<td>Grande</td>
<td>Ma</td>
<td>Big</td>
</tr>
<tr>
<td>Hijo</td>
<td>Guali</td>
<td>Son</td>
</tr>
<tr>
<td>Hombre</td>
<td>Guacokio</td>
<td>Man</td>
</tr>
<tr>
<td>Hombre bravo</td>
<td>Guaro</td>
<td>Brave Man</td>
</tr>
<tr>
<td>Hormiga</td>
<td>Bibujagua</td>
<td>Ant</td>
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<tr>
<td>Isla</td>
<td>Chiku</td>
<td>Island</td>
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<tr>
<td>Jardín</td>
<td>Mayna</td>
<td>Garden</td>
</tr>
<tr>
<td>Jefe</td>
<td>Cacique</td>
<td>Leader</td>
</tr>
<tr>
<td>Jove de oro para el cuello</td>
<td>Guanú</td>
<td>Gold necklace</td>
</tr>
<tr>
<td>Jova de oro para las orejas</td>
<td>Tatuga</td>
<td>Gold earrings</td>
</tr>
<tr>
<td>Lagarto grande</td>
<td>Iguana</td>
<td>Iguana</td>
</tr>
<tr>
<td>Luz</td>
<td>Cacú</td>
<td>Light</td>
</tr>
<tr>
<td>Lugar escondido</td>
<td>Guanara</td>
<td>Hidden Place</td>
</tr>
<tr>
<td>Luna</td>
<td>Cacaya</td>
<td>Moon</td>
</tr>
<tr>
<td>Marea</td>
<td>Para</td>
<td>Rain</td>
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</table>
Madre
Mar
Maiz
Matar
Mariposa
Montana
Mosquito grande
Muñer
No
Oyo
Piro
Padre
Pan
Peleras
Pez chiquito
Piedra
Puma
Plaza
¿Por qué?
Pueblo de indios
Provisión de viaje
Rana
Río

Savedor médico
Señor
Sí
Sirviente
Sal

Tabaco
Tambor de madera
Tierra
Tiburón

Vasija de barro para agua
Viejo

Bibi
Bajúa
Maiz
Yuca
Tanama
O
Corasi
Guariche

Ulán
Caku
Guana
Batu
Casabi
Bata
Seri
Siba
Aji
Batey
Anaque
Yuayque
Guahina

Coki
Ni teo

Bohique
Bajari, guajeri, guama, bo
Jay jai
Nabori
Güey

Cojía
Magney
Kó
Capaya

Canari
Guatucan

Mother
Sea
Corn
To kill
Butterfly
Mountain
Bug mosquito
Woman

No
Eye
Gold
Father
Bread
Bell
Small fish
Stone
Pepper
Plaza
Why?
Native village
Provisions for a trip

Small frog
River
Priest with medical powers
Visitor
Yes
Servant
Sun

Tobacco
Wooden drum
Earth
Shark
Earthenware water dish
Old
Crystals: More Than Meets the Eye

Lois Van Wagner

It is the purpose of this unit to acquaint the student with the intriguing world of crystals, their structure, formation, and uses. Most students when confronted with a well-formed quartz crystal, or a purple fluorite, or a polished geode, literally jump about demanding to know “Who made this?” and “How did they make this?” and the subject of diamonds and other gems is avariciously attended to with wide eyes and listening ears. Since the actual atomic structure can be drawn and modeled in a wide variety of mediums even the more humdrum aspects can be made inviting. And the chemical concoctions that can result in some homemade crystals bring out the white-coat scientist in even the most reluctant student. Many of the students own small personal calculators that are solar-powered, or have seen the advertisements in discount store circulars for solar powered exterior lighting. These objects provide a good jump-off point for discussions about crystals and technology.

My unit on crystals will be divided into three categories covering three areas of study. The first area will deal with the actual structure of crystals beginning with a look at the atom, some simple atomic drawings (Bohr models) of elements, and a study of the periodic table of the elements. Next we will look at compounds and their bonds. This will lead to the understanding of how crystals “look” and the shapes they can take. Within this section we will draw and construct in three dimensions paper models of six of the basic crystal shapes. We will also grow some of our own crystals in the laboratory.

The second major heading in my unit will focus on minerals. We will learn about the characteristics of a mineral: the chemical composition, mineral color, luster, cleavage, hardness (and how this property is related to crystal structure), and specific gravity. The characteristics of minerals lend themselves nicely to a mineral identification lab, and a lab on specific gravity of minerals and selected rock samples. Some of the other topics in this section will include a study of the various forms of quartz; gems, especially diamonds; the formation of mineral
crystals—by igneous, sedimentary, and metamorphic processes; and some stories of famous (or infamous) gems.

The final section of this unit will delve into the uses for crystals which modern technology has fostered, specifically solar cells, transistors, and liquid crystals.

The unit is designed for the middle school age level, specifically for the eighth grade Earth Science curriculum. In the two years that I have used this curriculum unit with my eighth grade classes I have amplified or omitted sections depending on the interest and abilities of the various classes. In this way I have been able to use the unit with students that range in ability from very high to very low.

Throughout this paper I am indebted to the teaching and guidance of Dr. Werner Wolf and to the following books and sources:


On the topic of liquid crystals: Frederick Kahn in *Physics Today*; and Glenn Brown and Peter Crocker in *C&EN*.


I. ATOMS, ELEMENTS, AND COMPOUNDS

The building blocks of all things are the tiny atoms that make up the many elements which we can see on the periodic table. The minerals we will be studying are made of these elements or combinations of elements called compounds. The basic atom is composed of positively-charged protons, negatively-charged electrons, and neutrons, which have no electrical charge at all. Protons and neutrons are located in the nucleus of a cell and have almost the same mass which is measured by a special unit called the atomic mass unit, or amu. A single proton or a single neutron has a mass of about one amu. The electron has a much smaller mass, only 1/1836 amu. There are always the same number of protons as elec-
trons, and therefore the same number of positive charges as negative charges are found in the neutral atom.

A. The Bohr Model

Although our best understanding of the atom tells us that the electrons are in constant and rapid motion around the nucleus and the exact location of any electron cannot be known, we can by experimental means determine the most probable locations of electrons and establish energy levels or shells which we can use to help us understand the relations of atoms. In 1913 a Danish scientist, Niels Bohr, developed a model that can be used by children to understand the way atoms combine into compounds. This model is called the Bohr model and shows a central nucleus with the protons and neutrons either drawn in or simply enumerated. Around this central core are the shells or energy levels. These levels are sometimes referred to as the K, L, M, N, O shells or alternatively, the first, second, third, fourth, fifth, energy levels. Each of these levels has a specific number of electrons it can maximally hold. The degree to which these shells are filled determines how readily it will combine with other elements and in what proportion.

Figure 1 illustrates a specific labelling technique that is quite easy to use with children and facilitates accuracy. Since the shells fill using definite laws and patterns involving energy, they are predictable. Beyond the element calcium, however, the laws become quite complex and need extensive explanation and understanding of subshells. It is wise, therefore, to limit the Bohr model drawing to that point at this grade level. Some periodic tables give the number of electrons in the energy levels as part of the information in the block for each element. By looking at this data, some of the students might come up with partial explanations for the building of these shells. In the absence of such data it is sufficient to declare the numbers 2 and 8 “magic numbers” and let them build the smaller atoms.

| Atomic Number | 9 | p=9 | K=2 |
| Symbol        | F | e=9 | L=7 |
| Atomic mass   | 19.0 | n=10 |
(where p stands for proton number, e stands for electron number, n stands for neutron number, and K and L represent the first two electron energy levels.)

After drawing out a few, or many, of the Bohr models the children will notice that some of the models have an outer shell that only needs one or two more electrons to be filled, and that others have one or two electrons that seem to hang awkwardly by themselves in their outer shell. These conditions can of course be used to develop an understanding of the terms metal and nonmetal. Since the children can “see” the electrons they can judge their availability for donating or receiving. This technique makes easy work of explaining compounds and their chemical formulas. It also aids in the explanation of ionic and covalent bonding.

**B. Ionic Bonding**

By drawing a Bohr model of sodium we can see that its K and L shells are filled and the one remaining electron is by itself in the outer M shell. It will take very little energy to coax that electron away from its atom, leaving only ten electrons with ten negative charges to balance with the eleven protons with their eleven positive charges. When this happens we will have an ion with a +1 charge. In the same way if we draw a shell that has seven electrons, one short of that “magic number” eight. In this case the chlorine atom would be very happy (anthropomorphically speaking) to grab another electron and fill that shell. In doing so the chlorine atom now would have seventeen protons and eighteen electrons, resulting in a net charge on the atom of -1. This would be a negative ion. When two elements come together in this way we refer to it as an ionic bond. The opposing charges on the two ions cause them to be attracted together.
C. Covalent Bonding

Next we will draw out an oxygen atom. In this case we can see that its outer shell has six electrons, two short of the "magic number" eight. And if we draw a hydrogen atom we can see that it has one electron in its outer shell, half of what it needs to fulfill the "magic" two count. From this we could deduce that by bringing in another hydrogen atom we can combine the three atoms into $\text{H}_2\text{O}$, and each atom's outermost shell would be filled. This is the basis for an understanding of covalent bonds, in which atoms come together and share electrons in their outer shells. The electron clouds overlap and the electrons circle both atoms.

The bonds of compounds can influence some substances physical properties. And bonds exist not just between individual atoms but also throughout a crystal. We can look at two forms of the element carbon for an example. Graphite is a slippery black solid, the bonds form sheets of carbon which slide loosely over one another. Diamond on the other hand is a hard, clear crystal with tight tetrahedral bonding that holds the carbon atoms of diamonds securely in place. The difference can be seen below in the illustration.

- regular tetrahedral crystal of diamond
- plane hexagonal nets of graphite
Further investigation of the importance of chemical bonds can be accomplished by a study of sugar and salt crystals. By comparing melting points and ease of crushing some simple inferences can be made about their bonds. Directions for this experiment are to be found in Appendix 1, Activity 1.

II. CRYSTALS AND CRYSTAL SYSTEMS

A. Unit Cells

When atoms or molecules are lined up in an orderly arrangement and connected by bonds, and these atoms or molecules have a repeating pattern, we can then say this material is a crystalline substance. The smallest subdivision of a crystal is a unit cell. It is a regular pattern of atoms held together by electrical forces or bonds. These unit cells are far too minute to be seen individually but can be combined together in incredibly large numbers to form visible shapes. As an example of the staggeringly large numbers of unit cells we are talking about we can take as an example sodium chloride, table salt. One typical salt grain has about $5.6 \times 10^{18}$ unit cells. (Each salt unit cell is composed of four atoms of sodium and four atoms of chlorine.)

B. Crystal Systems

When the unit cells group together they leave no empty spaces between themselves. This results in a limited number of crystal systems that can form. These systems can be grouped as follows:

1. Isometric or cubic—three edges of equal length and at right angles to one another.
2. Tetragonal—three edges at right angles but only two edges of equal length.
3. Orthorhombic—three edges at right angles but all edges of different lengths.
4. Monoclinic—two edges at right angle, the other angle not; and all edges of different lengths.
5. Triclinic—all three edges of different lengths and all angles not at right angles.
6. Hexagonal—two edges are equal and make angles of 60 to 120 degrees with each other. The third edge is at right angles to them and of different length.
Two activities which can be used with the students are to be found in Appendix 1 listed within Activity 2. The first is a simple introduction to the various crystal shapes by drawing them and identifying their title. The second activity applicable to crystal shapes using the diagrams given there. In doing so, the student can in very concrete terms understand the variety of angles and lengths involved.

C. Growing Crystals

Once the student has a basic understanding of what a crystal is, he or she is often anxious to create some crystals of his or her own. This provides a natural opportunity to introduce some new terms which they will use in their laboratory experiences.

Since most of their crystals will be formed by solution the student needs to add the words solute, solvent, and solution to his vocabulary. The solute is the substance being dissolved and the solvent is the substance doing the dissolving. A solvent can hold in solution just so much of the solute. At this point we say the solution is saturated. If there is less solute in the solution than it would ideally hold we would then say it is an unsaturated solution. And in some cases such as when we heat the solvent we can continue to add solute and it will dissolve. When the heat source is removed and the solution's temperature falls the extra solute may remain in solution. This fragile situation is called supersaturation and is the basis for our crystal growth experiments.

Solubility, or the amount of solute which can be dissolved in the solvent, is affected by a number of factors, one of which is the temperature of the solvent. Generally speaking we increase solubility of solid solute when we increase the temperature of the solvent. (This is not true of the solubility of gases in a solvent as is witnessed by anyone who has sipped a glass of warm, flat soda.) In Appendix 2 there are some solubility figures which the student can use to set up graphs of solubility curves.

Crystal growth is a very orderly and regulated process. A crystal grows from the southside with the atoms of the compound being added according to a very specific pattern. If there is not enough space for the crystal to grow unhindered it will increase only until it meets something which gets in its way and then stop. Often many small crystals begin forming at the same time, and they grow until their edges meet at varying angles. They do not join to form a single large crystal but rather remain a jumble of small individual crystals forming a polycrystalline mass. The adjoining faces of the crystals are called the grain boundaries.
These boundaries are particularly evident in metals which have formed by fairly rapid cooling of the molten form. During the cooling process innumerable small crystals form and grow until they bump into a neighboring crystal.

Crystals can form from the cooling or evaporation of solutions, or from the cooling of molten solid, or the cooling of vaporized substances. In Appendix 3 you will find a number of experimental techniques for demonstrating crystal growth and for student participation in crystal growing.

D. Impurities

While the regularity and order of crystals have been stressed thus far, it is important to note that this order can be disturbed. Generally the cause is the inclusion of an impurity. Sometimes this is the result of a crystal forming around a foreign particle. This can usually be detected by microscopic examination. But other times it is actually an invasion by an atom with approximately the same size and shape as the host crystal, and the pattern is not disrupted. This is called a *mixed crystal*. The classic example of this is alum which is composed of potassium sulfate and aluminum sulfate in a one to one proportion. A similar compound is chrome alum, in which you find potassium sulfate combined with chromium sulfate.

Many crystals in nature demonstrate this mixed crystal condition in the replacement of aluminum by chromium or sometimes iron. Rubies are a good example of this, being composed of aluminum oxide with chromium replacing some of the aluminum, and also sapphires which replace the aluminum with titanium and iron.

In some cases a slightly different atomic substance can enter a crystal but only in small quantities. This is called a *substitutional impurity*. A most relevant example of this is substitution of phosphorus or boron atoms in silicon crystals. These “impure” compounds are used to make transistors for electronic instruments.

Sometimes a different kind of impurity enters a crystal. These foreign atoms may be very small compared to the host substance and fit in between the orderly arranged host atoms. If the host substance has a generous size pattern the invading atoms could be as large as the host atoms themselves. The additional atoms are called *interstitial impurities*. A well known example of this is carbon and iron, which makes steel.

A third kind of defect could be called a *vacancy*. This results from very rapid crystal growth during which some of the atomic sites are simply not filled. The milky or veiled appearance of home-grown crystals, however, is caused by very
large openings called voids. It generally occurs when the evaporation of solvent proceeds too rapidly and incomplete crystallization happens. The white coloration is caused by the presence of a liquid solution that is trapped in the open spaces of the crystal. Vacancies on the other hand are far too small to be visible.

III. MINERALS

A. Definitions

What is a mineral? What makes it unique? These are questions that can be used to open up the subject to the student. They will often confuse the term with “rock” or think only of the more valuable forms such as rubies or diamonds. They may also want to include coal because they have heard it called a mineral resource, or pearls since they seem to fit in with the other gems. So a discussion of just what a mineral is would be in order.

Minerals are natural substances that are inorganic and not the result of any living process, therefore ruling out coal, oil, or pearls. It must also have a specific chemical formula, made up of atoms in a definite ratio. In addition the atoms must have a definite and specific arrangement in space. It is because of these characteristics that minerals have unique properties which can be used to differentiate them from one another.

B. Terms of Identification

Some of a mineral’s properties are easily determined by simple visual examination: crystal shape, color, and luster. The beginning student will generally try to identify a mineral by its color first. In the case of some minerals this may be successful—malachite is always green, zanrite is always blue, etc. But for most minerals the surface color can vary tremendously depending on impurities included in the crystal structure.
Many minerals are made up primarily of elements which impart no strong color of their own and only minute amounts of a coloring agent can have striking results. Some color guidelines are: red may indicate the presence of chromium or hematite, green can indicate chlorite or chromium, and blue can indicate the presence of titanium or titanium and iron. The presence of copper ions can result in shades of green or blue and manganese can result in shades of red. It is sometimes helpful to determine the color of a mineral's streak by rubbing the sample on an unglazed porcelain streak plate. This powdered residue is often more accurate in indicating true color and many mineral identification handbooks include a list of streak colors.

**Hardness** of a mineral is shown by its resistance to being scratched. This is related to the crystal structure in that the more tightly bonded the atoms the harder the surface resistance to being etched will be. Diamond is the hardest mineral but is not readily available for student experimentation. Corundum is the next step down and it inexpensively available. In 1812 Friedrich Mohs devised a rough scale of hardness that is invaluable in mineral identification. Diamond at number 10 is the hardest, and talc at number 1 is the softest. The intervals between the numbers are not equal, however, and the difference between corundum at 9 and diamond at 10 is greater than the entire range of 1 to 9!

**Mohs Scale of Mineral Hardness**

1. Talc  
2. Gypsum  
3. Calcite  
4. Fluorite  
5. Apatite  

6. Feldspar  
7. Quartz  
8. Topaz  
9. Corundum  
10. Diamond

*Cleavage* is a reflection of the electrical forces acting between the atoms which result in the crystal breaking along atomic planes that are parallel to crystal faces. The children are asked to look for these flat faces and simply to indicate whether the mineral has "good" cleavage or instead breaks with rather raggedy edges and is therefore declared to be fractured. Or if the student has already looked at crystal shape pictures and constructed paper models of them, they can try naming the crystal system it belongs to.

*Luster* is that mineral property which indicates the way light is reflected from the surface of the sample. Some luster terms are: glassy, metallic, greasy, pearly,
or satin-like. These are all terms the students are familiar with and can also be
used in conjunction with an identification manual.

Another means of identifying minerals is specific gravity. This measurement
can be the most helpful identifying characteristic of all as it is apt to be the most
reliable. The students can have a very interesting lab built around this property.
Directions for this lab are in Appendix 1, Activity 4.

The story of Archimedes and his quest for a way to determine the value of
the king's crown is a sure-fire attention-getter to start the lesson. According to
the legend, in about 250 B.C. Archimedes was given the task of determining if
a crown belonging to King Hiero was pure gold or only an alloy of gold and sil-
ver. It is said that upon easing into his tub the bath water spilled over the edge
and it came to him that the volume of water lost was the same as the volume of
his body, and he could use the same technique to determine the volume of the
crown. Since it was known that gold and silver have different densities, the
only thing that would remain would be to take an accurate measure of the
weight of the crown and divide this by the volume of the crown. The resulting
density figure could be compared with the density of gold, and the truth would
be known. It is said that with this revelation, Archimedes leaped from his bath
and ran, forgetting the state of his undress, through the streets of Syracuse in
Sicily exclaiming, "Eureka!—I have found it!" on his way to the palace! A sad
footnote to the story is that the crown was indeed not the pure gold it had
been portrayed as, and the unfortunate merchant met an uncomfortable end.
Or so they say.

Carried one step further, the concept of specific gravity is based on the
physical law that an object immersed in water loses as much weight as an
equivalent volume of water would weigh. With a spring balance and a water
pan the students can determine the specific gravity of a variety of minerals.
Experience has shown that fairly large specimens will give the best results.
See Appendix 1 for directions for labs on this and related topics; Activities 4,
5, and 6.
IV. THE QUARTZ FAMILY

A. Characteristics

Once the student has become familiar with some of the characteristics of minerals in general it is time to focus in on some specific examples. Quartz is a good one with which to work as samples of a variety of forms are easily obtainable and have the all-important virtues of both durability and beauty. Quartz is at position 7 on the Mohs scale which means that it is one of the hardest common minerals. It crystallizes from the molten state at rather high temperatures but also can be deposited on the ocean floor at only a few degrees above zero. It forms very beautiful crystals that can be used as gem stones and is the source of crystals used for technical purposes. It is also the major ingredient in sand. Flint is a historically important form of quartz due to its use in the early weapons used by man to hunt wild game.

In 1880 the Curies discovered another peculiar property of quartz while studying the electrical conductivity of crystalline bodies. They discovered that pressure on plates of quartz caused a deflection of the needle on a sensitive electrometer. This is called the piezoelectric effect. It occurs when the crystal is squeezed slightly out of shape and then springs back. This shape change actually affects the crystal at the atomic level causing a movement of ions, with their attendant electric charges. This motion of the electrically charged particles constitutes flow of electrons, or electricity. This particular characteristic is now used to control and stabilize the frequency of a radio transmitter or to regulate watches.

B. Types of Quartz

Probably the most familiar form of quartz is the clear, colorless form known as rock crystal. These crystals can range in size from the most minute to the gigantic; one from Brazil weighed in at 5.5 tons! This clear material has been used far back into history for carved goblets, bowls, and other objects.

Another form of quartz known and valued for its beauty is amethyst. This mineral is almost pure SiO₂ with only a trace of iron. As the amount of iron increases, so does the intensity of the violet color, so it is believed to be the coloring agent. According to folklore the amethyst gives its wearer great power, increased intelligence, and strength.
Smoky quartz does not differ from clear quartz in chemical composition. In fact when it is heated to very high temperatures the "smoky" color vanishes, and it looks identical to clear crystalline quartz. The color can be restored by treating the crystal with a beam of x-ray radiation. Scientists believe that the color of smoky quartz is a result of natural radiation in the earth.

Agate is a common form of quartz which does not have any external evidence of its crystal nature. The extremely tiny crystalline particles are so intergrown that they appear smoothly mixed. Agate is used decoratively and as jewelry, especially in the onyx form.5

A form of quartz that is unique and appears to be most "un-quartz like" is the opal. It contains a rather large percentage of water, ranging from four to twenty percent. And a complex internal structure of microscopic silica fitted together in a lattice-pattern results in diffraction of the light hitting it, forming rainbows of brilliant color as the gem is rotated. Opal is a low-pressure and low-temperature mineral and is formed at the earth's surface by deposition from ground water or by the evaporation of hydrothermal, or hot water, springs as they rise to the surface and cool leaving opal mineral behind. Because of the rather large amount of water present in opal, it tends to be relatively soft (5.5 to 6.5) and low in specific gravity. These qualities limit its use as a gem, and it is usually found mounted in pendants and pins where the stone is relatively protected.6

V. GEMS

A. Diamonds

Of all the gems diamonds seem to hold a special fascination for both children and adults. Perhaps this is due to all the adventuresome stories seen in movies and on television or perhaps it stems from a vague understanding of the tremendous forces that create diamonds and the vexing inability of man with his modern technology to duplicate this feat completely.

Man is not at a total loss in this field. Currently we are producing some 44,000 pounds for industrial use annually by a process developed by H. Tracy Hall for the General Electric Research Labs in the early 1950s. His process involved a mixture of graphite powder and an iron compound placed in a hydraulic press. This press was able to generate a force of more than 1.5 million pounds per square inch! To that was added an electrical current which heated the mix to
over 4,800 degrees Fahrenheit. From this was produced low quality diamond grit used widely for industrial purposes as an abrasive.

Gem quality diamonds are another story. Instead of the less expensive carbon sources which are used in the manufacture of industrial diamonds, the feed material for gem quality diamonds is the industrial grit, and the pressure and temperatures must be maintained for long periods of time, up to a week. From this we can obtain gem quality diamonds of up to one carat, but unfortunately the cost of manufacture is higher than the present cost of mining the natural stones.\(^7\)

Natural diamonds are thought to be formed deep within the earth, probably 90 to 120 miles down within the upper regions of the mantle. Here pressures of 975,000 pounds per square inch and temperatures of at least 2,700 degrees Fahrenheit may cause carbon atoms to crystallize into tetrahedral shapes of great strength. Diamond is more resistant to scratching than any other mineral, only another diamond can mark it. It is resistant to acids and alkalis. It is brilliant and has very high dispersive qualities which result in the flashes of light reflecting from the cut stone. Dispersion is the ability of a substance to separate white light into its component colors just as a prism or water droplets forming a rainbow. It also has a relatively high specific gravity, 3.5, which results in it being found in placer deposits, those areas in stream beds where heavy and often valuable particles settle out and collect in quantity.

Diamonds were first found in India and for thousands of years this was the only source. They were not mined but rather found in stream gravel and alluvial deposits. Some famous stones from India with fascinating histories are the Koh-i-nor and the Great Mogul. In the early 1700s diamonds were discovered in Brazil. Men panning for gold found clear pebbles that were later recognized as diamonds! Many of these South American gems were shipped to India to be sold in their markets to Europeans. As India’s sources began to dry up, Brazil became more acceptable in the world’s eyes as a diamond source. And so for a while Brazil was the principal producer of diamonds. Even today many fine gemstones come from there.

The most extraordinary diamond finds have occurred only within the last one hundred years or so. In 1866 a Boer farmer’s son found a shiny pebble on a river bank in South Africa. It turned out to be a 21.5 carat diamond! Adventurers from all over the world descended on the site turning it into a free-for-all not unlike the American gold rush. Diamonds were recovered from the river bank, the surface soil, deeper “yellow ground,” and finally at depths of fifty to sixty feet, the “blue ground.” This rock is the original matrix which the diamonds formed in more than 15 million years ago. Diamonds have also been found
beneath the beach sand at the mouth of the Orange River and now mining is being done in the Atlantic Ocean in that area.  

Very few diamonds have been found elsewhere in the world. An occasional gem has been found in the American midwest in glacial deposits or in dunes. And in Arkansas some have been found in their rock matrix similar to the blue ground of South Africa. They have also been found in the Soviet Union, but not much is known about these.

**B. Rubies and Sapphires**

Two gems which are color variations of the same mineral, corundum, are ruby and sapphire. Rubies contain a small amount of chromium, and sapphires have titanium. They are very hard minerals, 9 on the Mohs scale, and have a high specific gravity, 4.0. This allows them to survive being washed great distances into alluvial placers. An interesting variation of these gems is the “star” form which results when needle-like impurities are aligned at angles of sixty degrees to each other during the formation of the stone. Unlike the highly organized and businesslike enterprises that mine diamonds, the mining of rubies and sapphires is a haphazard, sometimes dangerous endeavor. Most of the rubies come from Burma or Thailand and sapphires come from Sri Lanka, Australia, and surprisingly, Montana in the United States. Many of the stones travel rather dubious routes and are handled by smugglers and contraband dealers in open-air markets guarded by local police armed with automatic rifles.

**C. Emeralds**

Emeralds are quite different from their sister gems in that they are quite soft, only 7.5 on the Mohs scale. They are the green form of beryl, colored by the presence of chromium or vanadium. If rubies have wild tales to tell, emeralds out-do them every time.  

Like something out of an Indiana Jones story the history of emeralds includes torture, conquistadors, native slaves imprisoned in tunnels, and lost treasure maps. Both of the major emerald-producing regions in Colombia have violent and greed-filled pasts and presents. One of the areas had to be closed down due to the astronomical numbers of murders and other crimes there. In addition to the problems created by the human element, the mines are plagued by mining-technique problems. The preferred mode of obtaining the emeralds involves dynamiting the parent rock. Although this does speed up the
rock removal process, it also fragments many of the emeralds crystals. As an example, the 632 carat Patricia emerald was uncovered by a dynamite blast which also destroyed what appeared to be an even larger stone! Although emeralds are quite soft as gems go, they are often mined from alluvial deposits. The places they are found, however, are never far from their source or else they would be very eroded. Colombian stones are taken directly from the parent rock. Other countries which produce emeralds are Zimbabwe, Zambia, and Brazil. Their stones are considered, however, to be somewhat inferior in color or size.  

D. The Origins of Mineral Crystals

Although the geologic processes which produce minerals, gems, or otherwise, vary in their specifics, there are some generalities to their origins. Like all rocks they form by either igneous, sedimentary, or metamorphic means. Igneous formations would include diamonds, rubies, sapphires, topaz, and garnet. These form when magma wells up through cracks and fissures and is trapped in molten pockets. There, water, dissolved gases, and rare elements combine and crystals begin to grow as the molten mass slowly cools. The rock it forms is a mixture of minerals called pegmatite characterized by its large chunks or crystals. With just the right chemicals present and just the right ambient conditions this pegmatite will hold precious gems.

Sedimentary formations may contain gems with two separate histories. Some of the sedimentary rocks hold crystals that were formed elsewhere and then were moved by erosional forces to sediment basins where they became part of the deposit. Other gems were formed when groundwater seeped down through the volcanic ash or other sediments dissolving minerals and moving them into pockets. Opal and turquoise are examples of this type of gem.

When tectonic processes, volcanic activity, or deep burial subject rock to great heat and pressure, metamorphic forms may result. The partial melting of the parent rock allows specific minerals to escape and move to areas where they concentrate into gems. Examples are garnets, which can be found here in Connecticut, and the famous Burmese rubies and sapphires.

E. Geodes

Geodes are hollow balls of mineral with numerous well-developed crystals lining the walls of the interior. The formation of geodes is not well understood and
there are several theories that attempt to explain these unusual shapes. Some geologists feel that they are merely hollow spaces formed by gas bubbles trapped in molten rock when it cooled. This would allow space for the projecting crystals to form but does not explain the ease with which the geode separates from the host rock. Other geologists think the round shape was originally formed as a concretion which later eroded away leaving a hollow space in which crystals grew. Still other researchers put forth a rather complicated geologic scenario involving a hollow of undetermined origin, its filling with fluids, including a gelatinous silica layer which provides a semipermeable membrane for osmotic movement of water into and out of the open space, and as a final step the dehydration of the gel and the subsequent formation of crystals from mineral rich waters that leak into the opening through cracks.

Displaying geodes to the students is an extremely valuable tool as it is obvious to the group that the individual perfectly formed crystals could not have been carved out by man. This idea of the human manufacture of crystals, especially the particularly beautiful quartz or pyrite crystals, is quite common among students at this grade level.

VI. CRYSTALS AND MODERN TECHNOLOGY

A. Introduction

Crystals have been valued by man throughout history as building materials or ornamental objects. Today they are further valued as technological materials. Solar cells and semiconductors are two recent developments based on the unique properties of certain crystals. Liquid crystals are another source of exciting possibilities for the future.

B. Solar Cells

Solar cells are perhaps the most familiar to the student, as many of them own solar-powered calculators, or have seen the solar panels on various space vehicles. Inexpensive solar toys are available for student assembly which emphasize the rather simple nature of their operation. The energy produced by the solar cell is also called photovoltaic energy. The solar cell is made of silicon which has been infused with an impurity such as boron. Silicon has a strongly bonded tetragonal crystal with pairs of shared electrons uniting it to its four neighbors.
When the boron is added as a substitutional impurity (see section II D) it will share its three valence electrons with three of its silicon neighbors but is lacking a fourth electron to share with the fourth silicon neighbor. This absence of an electron is called a hole. So the addition of boron results in a "hole" which is considered to be a positive charge. Next we diffuse a very thin layer of phosphorus into the top of the boron silicon. Phosphorus is different from boron in that it has five valence electrons, one more than it needs to join into the stable bonding with silicon. So this extra electron is free to move among the electron shells, in some cases filling in boron holes, but usually resulting in an excess of electrons moving around. These are called conduction electrons. The silicon region with holes is called the "p-type layer" and the region with the excess of conduction electrons is called the "n-type layer."

As the conduction electrons move in to fill in the holes, a peculiar thing happens. The boron atoms which take up the electrons in their holes now become negative ions! And the phosphorous which has given the conduction electron up now becomes a positive ion! This results in a boundary called the p-n junction where holes with their positive charge and electrons with their negative charge are repelled by the charged ions that set them loose. So the excess conduction electrons are unable to move across the boundary to fill in the holes. This results in electrons building up in the n-type layer and holes will collect in the p-type layer.

Electrons move toward the p-type side and holes (positive) move toward the n-type side until a dynamic equilibrium is reached. Ionized boron repels further movement of electrons and ionized phosphorus repels further movement of holes (positives).

When photons strike the solar cell, bonded electrons are bounced right out of their positions creating many more conduction n-electrons and holes on both sides of the junction. Since there are already so many electrons on the n-type side and so many holes on the p-type side, the additional new ones are only a tiny proportion;
but by making new holes on the n-type side and new conduction electrons on the p-type side, the solar cell is unbalanced. The electrons from the p-type side move across the junction creating a flow of electrons, or electricity! This flow moves electrons out through the n-type layer onto a conductive wire grid which is connected to a circuit that is completed by an attachment to the p-type layer. Read more about this fascinating but complex topic in Chalmers' article or Swan's book.

Solar cell circuit in which conduction electrons move toward the n-type crystal where they travel to the current collector on the surface of the cell and move through the external circuit to the p-type crystal area.

C. Transistors

Transistors are constructed of the same types of materials as described in the section on solar cells. These materials are called semi-conductors and when bonded together form a p-n junction which is influenced by the addition of a voltage differential placed across it rather than the effects of photons of sunlight. When these thin layers of semi-conductors are sandwiched together they make up a transistor which can be used to regulate the flow of electrons in circuits, detect and amplify radio signals, produce oscillations in transmitters, and act as
digital switches. These tiny solids were the first electrical components in which materials with different electrical characteristics were physically joined by structural contact rather than by wires.\textsuperscript{14}

D. Liquid Crystals

Another interesting crystal technology involves a crystal which is not a solid. The melting point of a pure crystalline substance is very precise. And in some cases the crystalline properties of a solid crystal carry over into the liquid state. There are many compounds that will do this. Their atomic structure remains quite orderly even while taking on the other characteristics of typical liquids such as pouring or taking on the shape of its container. Selective reflection of white light into its various spectral components by these liquid crystals can be directed and controlled by thermal, acoustical, electrical, magnetic, and even mechanical means. Wrist watches and clocks whose numbers melt from one display into another are liquid crystals. Window glass can be made dim or clear depending on the intensity of the sunlight passing through. An exciting futuristic application of the liquid crystal would be flat plates or screens hung on walls which display television images.

The simplest or first generation display capability with a single electrical lead connected to a single picture element forms the seven-segment number displays as seen on clocks and watches. Second generation displays attach four picture elements to one electrical lead and displays the seven segment numbers and also starburst shapes which can form letters or numbers, useful for pocket calculators.\textsuperscript{15}

More complex wiring and liquid crystals with helical (spiral) axis positions can display 5–32 elements per electrical lead and are used for personal computers. The newest experimental versions are capable of producing TV picture displays on a flat substrate.

Liquid crystals are true liquids but also have some solid properties. Their internal order is very delicate and can be changed by a weak electrical field, magnetism, or even temperature variations. Noticeable optical effects are the result of re-arrangement of the molecules and the resulting changes in refraction (light-bending), reflection, absorption, scattering, or coloring of the visible light from their surface. Liquid crystals modify the ambient light rather than emit their own light and therefore require minimal amounts of power. A typical LCD (liquid crystal device) uses one microwatt per square centimeter of display area.\textsuperscript{16}

A very simplified diagram below shows the effect of an electric current on liquid crystal molecules. This change is visible due to its effect on light waves.
Some liquid crystals are sensitive to temperature, and are used as a component in thermometers. They can be used in diagnostic tools to detect cancers, pulmonary disease, and vascular diseases. Their dramatic color variations are caused by an actual helical swing of 360 degrees by the molecules! The diagram below shows this 360 degree reorientation process.17

A uniform starting position for the crystals is vital to their usefulness. Liquid crystals can be aligned by “rubbing” of the substrate. Until recently this was poorly understood but used as a standard practice anyway. It is now known that the rubbing results in microgrooves which serve to orient the molecules.18

Although liquid crystal technology has only recently been exploited by man for diagnostic tools, displays, new materials such as kevlar, and oil-recovery technology, nature has used these peculiar molecules in living systems right along. The structure of cell membranes and some tissues are liquid crystals. Hardening of the arteries is a result of the deposition of liquid crystals of cholesterol, cells involved in sickle cell anemia have liquid crystal structure, and on a brighter note, it may soon be possible to change the solid form of a gall stone into a liquid crystal form that can be flushed from the body.19 For further information see the Brown or Kahn articles.

The technological development of crystals has taken off in this generation from semiconductors to transistors to integrated circuits to microchips. Always getting smaller but with vastly increased information handling abilities. They are the mainstay of the space and military industries, making possible the impossible in distant space travel, satellite technology, and weapons’ accuracy.
Solar cells are becoming more efficient and more common, and as our energy problems increase, student interest in solar technology has also increased. And the liquid crystals in our students' watches and pocket calculators are just one more bit of technology waiting to be explained to our students.

There are many very helpful books and articles which can aid the reader in his or her understanding of these interesting, complex topics. Many of these have been listed in the bibliography, but I would like to specifically recommend the Holden book, *The Nature of Solids*, and the Chalmers article, “Photovoltaic Generation of Electricity,” as two excellent readings with which to begin. They will provide you with the information you will want to feel confident about teaching about crystal technology.

All of the books and articles that are specifically referred to in the text of this unit are available in book or reprint form at the Yale-New Haven Teachers Institute office on Wall Street, New Haven.

APPENDIX 1

Activity 1

**Objective** to observe the properties of two substances with different kinds of bonds.

**Materials**
- three metal teaspoons
- 2 cm table salt
- magnifying glass
- 2 cm table sugar
- matches
- folded paper towel or hot pad

**Procedure**
1. Rub a few grains of the salt and then the sugar between your fingers. Which one feels the sharpest or the roughest?
2. Examine with the magnifying glass a few grains of both salt and sugar. Describe the grain shape of each.
3. Put some of the salt in a spoon. Crush it with the other spoon. Do the same with some of the sugar. Which is the most difficult to crush?
4. Light a match or a candle. Hold the teaspoon of salt over the flame for ten seconds. Does it melt? Do the same with a teaspoon of sugar. Which substance appears to have the higher melting temperature?

Record all of your data in the chart below as you do each test.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Table salt</th>
<th>Table sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roughness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain Shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melting point</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions**

1. Use your book to find out what kind of bonds salt and sugar have.
2. Which of these two substances appears to have the stronger bonds?

**Activity 2**

**Objective** to familiarize students with the shapes of crystals in their three dimensional forms.

**Materials**

- pencil
- crystal model outline sheets, 1 and 2
- scissors
- tape
- drawing paper

**Procedure**

1. Look at drawings of the six basic crystal shapes. Draw and label each one on drawing paper.
2. Using the outline sheet cut out each crystal pattern. Fold along the dotted lines and tape the edges. Identify each shape using your drawings done in part 1.
Crystal model outline sheet #1
Activity 3

Objective  to demonstrate in concrete fashion the relationship between atomic arrangement and crystal shape.

Materials
- 12 one inch size Styrofoam balls
- 12 one-half inch size Styrofoam balls
- green crayons or paint
- toothpicks
- salt
- magnifying glass

Procedure
1. Color the large Styrofoam balls green to represent chlorine atoms. The smaller size balls will represent sodium atoms.
2. Break a toothpick in half, push one end into the chlorine and the other end into the sodium. Do this to all the “atoms” you have. Now you have sodium chloride molecules.

3. Using the toothpick halves join one NaCl (sodium chloride) molecule to another, matching up sodium to chlorine each time, and at right angles to one another. They should be placed as tightly together as possible. Look at the diagram to get an idea of how it should look.

4. Sprinkle some of the salt grains on a dark surface and inspect them with the magnifying glass. What shape are they? What is the chemical name for this compound?

Questions
1. What shape is the salt crystal?
2. What shape does the Styrofoam ball model of the atoms have?
3. Is there a relationship between the answers to questions 1 and 2? Why?

Activity 4

Objective to understand the meaning of specific gravity by determining the specific gravities of several mineral samples experimentally.

Materials
- thread or string
- water
- spring scale
250ml beaker
mineral samples:
  pyrite
  quartzite
  galena
  others

Procedure
1. Tie a twelve inch length of thread to the first sample, then tie the other end to the spring scale. Record the mass on the chart.
2. Fill the beaker about two-thirds full with the water. Submerge the sample in the water being careful not to allow the mineral to touch the bottom or sides of the beaker. Record the mass on the chart.
3. Subtract the mass in water from the mass in air. This is the "loss of mass in water." Record this on the chart.
4. The "loss of mass in water" amount is the same as the mass of water displaced. Enter this on the chart.
5. Use the formula below to calculate the specific gravity of your mineral.

   \[
   \text{Specific gravity} = \frac{\text{mass of the mineral in air}}{\text{mass of the water displaced by the mineral}}
   \]

6. Repeat steps 1-5 for each of the samples available.

<table>
<thead>
<tr>
<th>DATA CHART</th>
<th>Pyrite</th>
<th>Quartzite</th>
<th>Galena</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass in air</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mass in water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>loss of mass in water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>mass of water displaced</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>specific gravity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions
1. Pyrite is called fool's gold. How can you tell it from real gold?
2. What is an alloy and how can you differentiate it from a pure sample?
3. Use the *Handbook of Physics and Chemistry* to find the material with the highest and lowest specific gravity.
Activity 5

Objective to determine density of solids using the direct measurement of the volume of the solid.

Materials

- metric ruler
- balance beam scale
- assortment of blocks:
  - pine
  - balsa wood
  - Styrofoam
  - ceramic tile
  - steel plate

Procedure

1. Carefully measure the length, width, and thickness of the block using the metric ruler. Fill in the table below with your results.
2. Calculate the volume by multiplying the three numbers and enter the results in the designated space.
3. Use the balance beam scale to determine the mass of the block in grams. Enter the result in the designated space.
4. Calculate the density and record your answer.

\[
\text{Density} = \frac{\text{mass}}{\text{volume}}
\]

5. Repeat the above procedure for all of the blocks and carefully record all of the measurements and results of calculations.

<table>
<thead>
<tr>
<th></th>
<th>pine</th>
<th>bark</th>
<th>balsa</th>
<th>styrofoam</th>
<th>tile</th>
<th>steel</th>
</tr>
</thead>
<tbody>
<tr>
<td>length</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>width</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>thickness</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>volume</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>mass</td>
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<td></td>
</tr>
<tr>
<td>density</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Questions
1. What is the definition of density?
2. Could you use this technique to determine the density of a toy soldier? Why?
3. Could you use this density formula to find the density of a steel ball? How?

Activity 6

Objective  to determine the density of an irregularly-shaped solid using the displacement method.

Materials
- balsa wood block
- balance beam scale
- metal plate
- graduated cylinder
- small stone
- 250 ml. beaker of water
- metric ruler
- paper towels
- thread

Directions  We have measured the density directly by using a ruler to find the volume of a regularly-shaped object. We can determine the density of an irregularly-shaped object using the displacement method. We will weigh the object on the scale to find mass; then we will use the graduated cylinder to find out how much water is displaced by the object when it is submerged. The amount of water displaced is the same as the volume of the object. Then we have only to put the numbers in our formula:

\[
\text{Density} = \frac{\text{mass}}{\text{volume}}
\]

*Important Information: one milliliter = one cubic centimeter (1 mL = 1 cm³)*

Procedure
1. Weigh the three objects. Record the data on the chart below.
2. Fill the graduated cylinder to the 50 mL line with water from your beaker.
3. Securely tie each object with a 30 cm. length of thread.
4. Submerge one of the objects in the graduated cylinder. Record the new water level on the chart below. Repeat for each object.
5. Subtract the first reading (50 mL) from the second reading. This is the volume displaced, or the volume of the object.
6. Divide the mass by the volume to find the density. Remember 1 mL = 1 cm$^3$.

<table>
<thead>
<tr>
<th></th>
<th>balsa</th>
<th>metal</th>
<th>stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>mass</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>second reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(water and object)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>first reading</td>
<td></td>
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<td>(water only)</td>
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<td>volume displaced</td>
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<td>density</td>
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Activity 7

Objective  to develop skills in mineral identification using some characteristics of minerals.

Materials
- mineral samples
- penny
- steel nail
- hardened file
- streak plate
- compass
- paper towels
- lemon juice or dilute hydrochloric acid (Use acid only on samples kept at demonstration table—do not contaminate your samples at your desk.)

Procedure
1. Read each mineral identification characteristic and use the suggested term or property to describe the mineral you are examining. Repeat for each mineral.
2. Characteristics:
   - Color: apparent external color: black, brown, gray-white, brownish-white, etc.
   - Luster: describes the shine or light-reflection from a mineral: metallic, pearly, greasy, glassy, silky.
**Hardness:** describes the resistance to scratching and is measured by the Mohs scale of hardness, #1 to #10, softest to hardest. To test hardness, scratch your sample with the following items in order. When a visible scratch is made (a dent in the rock), that is the hardness.

- 2.5—fingernail
- 3—penny
- 4-5—steel file
- 6—hardened file
- over 7—may scratch a plate but leaves no color

**Streak:** describes the color of the powdered mineral. The streak can have a different color from the external apparent color. It is determined by rubbing the sample firmly over the plate, the color on the plate is the streak. A mineral of hardness 7 or over will have no streak, but may scratch the plate instead.

**Magnetism:** minerals that are magnetic will cause a compass needle to spin.

**Crystal structure:** Use your paper crystal models to determine the crystal shape of your sample.

**Acid test:** Put one or two drops of a weak acid on your sample (be sure to use the samples on the demonstration table). If the mineral bubbles and fizzes it contains carbonate. The gas being released is carbon dioxide.

**Heft:** refers to the weight per volume or size. Terms that could be used would be “heavy,” “medium,” or “light.” These are only relative and imprecise terms but useful for comparing with specific gravity.

<table>
<thead>
<tr>
<th>Name of Sample</th>
<th>Color</th>
<th>Luster</th>
<th>Hardness</th>
<th>Stress</th>
<th>Magnetism</th>
<th>Crystal Structure</th>
<th>Acid test</th>
<th>Heft</th>
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## APPENDIX 2

### Problems

The solubility of a solute in a solvent generally, but not always, increases as temperature increases. You can set up a graph to show solubility by plotting the temperature horizontally and the gram mass of the solute vertically. Use the data below to find the solubility curve for each substance.

<table>
<thead>
<tr>
<th>sodium nitrate</th>
<th>temperature (degrees Celsius)</th>
<th>solubility (grams/100 cc. water)</th>
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<tbody>
<tr>
<td></td>
<td>25</td>
<td>90</td>
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<td>75</td>
<td>125</td>
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<td></td>
<td>100</td>
<td>170</td>
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<table>
<thead>
<tr>
<th>sodium chloride</th>
<th>temperature (degrees Celsius)</th>
<th>solubility (grams/100cc. water)</th>
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<td></td>
<td>100</td>
<td>40</td>
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</tbody>
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<table>
<thead>
<tr>
<th>sodium sulfate</th>
<th>temperature (degrees Celsius)</th>
<th>solubility (grams/100cc. water)</th>
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<tbody>
<tr>
<td></td>
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<td>55</td>
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<table>
<thead>
<tr>
<th>potassium chloride</th>
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<th>solubility (grams/100cc. water)</th>
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<td>35</td>
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<td>75</td>
<td>50</td>
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<tr>
<td></td>
<td>100</td>
<td>58</td>
</tr>
<tr>
<td>sodium sulfate temperature (degrees Celsius)</td>
<td>solubility (grams / 100cc. water)</td>
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<td>.70</td>
<td>4.71</td>
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<tr>
<td>10.25</td>
<td>9.21</td>
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<tr>
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<td>75.05</td>
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<tr>
<td>89.85</td>
<td>42.67</td>
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<tr>
<td>101.90</td>
<td>42.18</td>
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Problems:
1. What is the solubility of sodium nitrate at 60 degrees Celsius?
2. What is the solubility of potassium chloride at 90 degrees Celsius?
3. What is the solubility of sodium sulfate at 50 degrees Celsius?
4. What is the solubility of sodium nitrate at 30 degrees Celsius?

APPENDIX 3

Growing Crystals

In this section you will find condensed directions for making crystals from a solution, from a melt, and from a vapor. You will find it very helpful to obtain Elizabeth Wood's book, *Crystals—A Handbook for School Teachers*, or the Alan Holden book, *Crystals and Crystal Growing* for troubleshooting or for more extensive examples and explanations. These books can be borrowed from the New Haven Teachers Institute office.

To grow crystals from an *alum solution* dissolve 4 teaspoons of alum powder in a half cup of hot water. Stir until all of the powder dissolves. Cover the beaker with paper or cloth to keep the dust out and slow evaporation. Crystals will begin to form on the bottom of the container. It is important to keep your solu-
tion free from drafts or temperature changes. If your room has a widely varying temperature range, set the beaker in a large bucket of water, being careful not to get extra water in the beaker. The water will help prevent any rapid temperature changes.

When some good size crystals have formed, pour off and save the solution and carefully pick out the best crystals with tweezers. Dry the crystals and the tweezers well. Now pour the solution back into the beaker with the remaining crystal masses and gently reheat and redissolve the solute.

The next step is a real test of your dexterity! You must fasten the crystal to a thread, either by means of a slip knot or with a minuscule spot of glue (Duco cement is good). Suspend your hanging crystal “seed” in the cooled solution and cover the top. It is important to be sure there are no extraneous crystal grains on the sides of your crystal seed, on the thread, or in the container. Growth of your seed will be impeded by them. Again place the beaker in the water bath to control temperature during the growing time. This process would result in a single, large, well-formed crystal.21

Other substances which can form nice crystals are borax, salt, sugar, copper sulfate, and Epsom salts. The amount of solute will vary, but you can determine the appropriate amount by trial and error or by checking one of the books given above.

To grow crystals from a melt, obtain some salol (phenyl salicylate, \( \text{HOC}_2\text{H COOC}_6\text{H}_4 \)) from a drugstore. Put a small amount on a glass slide or sheet of aluminum pie plate, and heat it with a candle. Since it melts at 42 degrees Celsius, you will not need much flame. As it cools, put a tiny grain of salol powder on the melted salol; this will act as a seed for the crystal to grow around.22

To grow crystals from a vapor, obtain some naphthalene (moth-flakes, \( \text{C}_{10\text{H}_8} \)). CAUTION—NAPHTHALENE IS VERY FLAMMABLE AND MUST NOT BE HEATED NEAR AN OPEN FLAME! Woods suggests placing a few flakes in a tall glass jar and placing a loose cover (aluminum foil) on top. Place the base of the jar on a lighted 100 watt bulb, and soon you will see the rising vapor sublimating (changing from vapor to solid) onto the top sides of the container. This experiment should be done in a very well ventilated room, preferably within a vented hood.23

Notes

2Ibid., 15.
‘Ibid., 225-230.
3 Hurlbut, 242.
4 Ibid., 248.
5 J. Arem, Man-made Crystals, 45.
6 C. Hurlbut, 212-216.
7 P. O’Neil, Gemstones, 82.
8 Ibid., 88.
10 C. Swan, Sunce: Energy, Economy, Photovoltaics, 56.
11 B. Chalmers, 38.
14 Ibid., 66.
16 F. Kahn, 70.
17 G. Brown and P. Crooker, 36-37.
19 Ibid., 40.
20 Ibid., 48.

Annotated Teacher Bibliography


Dana, E. Minerals and How to Study Them. Revised by C. Hurlbut. New York: John Wiley and Sons, 1949. Old but very complete guide to minerals. Crystallography discussed in detail and it has a convenient compact size and is easy to understand.


Swan, C. *SunCell: Energy, Economy, Photovoltaics*. San Francisco: Sierra Club Books, 1986. A comprehensive guide to solar energy dealing with everything from the physics of the cells, the practical uses, the future uses, to the politics and economics of solar energy.


6
Seascapes: Beginning Explorations
Phyllis Taylor

INTRODUCTION

Today we're going to begin a new exploration, a voyage. We're going to learn about water, boats, marine life, and men of the sea—watermen. While we're studying the seascapes and the lives of others, we will also start to explore the patterns and seascapes of our lives. Why is mankind fascinated by the sea? What elemental drives have urged man to explore the unknown? Why by sea? What urge compelled you to want to explore the oceans?

"Man hoisted sail before he saddled a horse . . . Watercraft were man's first tool for his conquest of the world," says Thor Heyerdahl in the Early Man and the Ocean.

In his book Heyerdahl demonstrates that it was much faster and easier to carry goods by water than overland. Tons of goods could be transported hundreds of miles by water.

Is it just practicality then that causes man to venture on the waterways—the easiest way of getting from one place to another? What about the present day? Why do men still explore the sea when faster and safer methods of travel are now available? In this unit we will explore some possibilities.

BACKGROUND

The life of our seas is important to every person on earth. Even if a man or woman has never seen the major oceans and lives in the middle of a vast desert, the quality of his or her life is dependent upon the conditions of the seas.

Throughout centuries, mankind has used the seas for water, commerce, conquest, food, power, recreation, transportation, and waste disposal. The development of sea craft and mankind's increasing explorations have determined in
large measure the place in which we live, the languages we speak, and the way we think of our world. Today, with an ever-growing world population, and geometrically increasing dependency upon the world's water, we are in danger of poisoning our children and ourselves and consequently, our entire world. By educating our children and ourselves about the sea and its importance to mankind's survival, we may foster prudent use of our waterways and prevent worldwide destruction of our most important resource, water.

This is an English unit which uses the theme of ocean exploration as a basis for teaching reading, thinking, writing, and speaking. This unit is intended as an introduction to the language and lore of the sea and is meant to be used with high school freshmen, although it may be adapted to other grade levels. In addition to the development of basic English skills, this unit has as a goal the extension of students' knowledge and awareness of the sea. As a central part of this unit, students will develop a log wherein they will explore not only the physical aspects of this world, but also their own mental and, to some degree, emotional selves. I hope that one outcome of this unit will be that the students will understand our symbiotic relationship with the sea and the need to respect the oceans. It is also hoped that in the future they will desire to work actively to save our coastal environments.

General objectives for this unit are:

1. To improve skills in reading, understanding, and analyzing specific works of poetry, fiction, and non-fiction.
2. To learn vocabulary of the sea, and to increase working vocabulary generally.
3. To become familiar with selected literature of the sea.
4. To practice and to improve skills in writing by answering questions, writing observations, narratives, summaries, log entries, and other writing activities.
5. To gain skill in critical thinking and speaking by participating in group discussions, presentation, and problem solving activities.
6. To understand mankind and his relationship to the sea by observing how other men have worked with the sea and analyzing one's own experiences on the ocean.

The presentations in this unit are not intended to be followed recipe style. They are presented merely as suggestions that the teacher may choose to select or to adapt to his or her own way of working. Before beginning with a unit of this kind it is important to understand a little about the water which surrounds us.
THE SEAS

To understand the importance of the oceans in our lives, we must go back, briefly, to the beginnings of the earth. Current theory maintains that as the earth cooled, hydrogen and oxygen—water's components—formed water vapor. As the earth's crust continued to cool this vapor began to rain—for centuries, creating the lakes, rivers, and oceans of the earth.

Today, every drop of this original water is still in use. The cycle begins as water vapor which, moved by air currents and changing temperatures, becomes liquid or solid and falls upon our world.

This water flows into the waterways and splatters onto the ground. Water then seeps below ground and sinks through our rivers, lake and stream beds picking up salts, minerals, and earth as it travels. Eventually, this mineral-rich water travels to the oceans where wind and temperature evaporate large amounts of the water and the process begins again.

Over ninety-seven percent of all the water on earth, according to the U.S. Dept. of the Interior, is held in the oceans. 2.15 percent is frozen in glaciers and polar caps, and the rest, less than one percent, make up the lakes, rivers, streams, and underground water deposits. Only six-tenths of one percent of all the water in the world is available for use by mankind and nature as surface ground water.¹

Seventy-one percent of the earth's surface is covered by our seas and oceans. Within the oceans lie whole mountain ranges, large valleys up to six and one-half miles deep, entire rivers of current, and seemingly infinite forms of sea life including today's largest animal, the whale. The ocean offers vast resources in the form of food, and has been traditionally a source of good, cheap protein, making fishing a thriving industry in any coastal community.

Additionally, the ocean contains every element found on dry land including, according to James Dugan in World Beneath the Sea, "... an estimated ten million tons of gold, 500 million tons of silver, and twenty billion tons of uranium."

From the same text Dr. John Mero, president of Ocean Resources Inc., one of the companies pioneering in ocean mining, states: "The dangers and the lack of technology have slowed the development of ocean mining. But I think that within the next 30 years offshore mining will be a five-to-ten million dollar industry. . . . By the year 2000, offshore wells will supply fifty percent of the world's oil."

The potential of the sea also includes its power. Today, around the world, several countries use the ebb and flow of the tides to generate electricity.

Furthermore, the value of the seas for recreation must not be underestimated. In 1968, Dr. Edwin Winslow and Alexander Bigler, planners, found that 112 mil-
lion people spent approximately fourteen billion dollars on ocean-oriented recreation in the United States. This figure surpassed the money spent to buy fish caught by our fishing industry and petroleum products resulting from our offshore oil wells. Recreation is the largest of all the industries derived from the seas.\(^2\)

If we think in terms of human lives rather than millions of dollars then the most important of all the sea’s resources is fresh water. James Dugan states that over 100 million gallons of water flow every day from the world’s desalination plants. Key West Florida with a population of over 34,000 depends upon such a plant to fulfill all of its water requirements.

Despite the assets gained from the sea, mankind is the cause of a major liability—pollution.

In another quotation from World Beneath the Sea James Dugan asserts: “In the United States some fifty-two million people, one-fourth of the population, live within 50 miles of the sea coasts. From these congested areas, a torrent of domestic and industrial effluents spill directly into bays, estuaries, and coastal waters.”

Add to these effects the poisoning of the sea from the world over and it is easy to see the unhappy consequences on us all. Because the oceans are in many ways a dominant factor in the total environment, mankind’s interference in any one element may affect the entire world in ways that we don’t yet understand.

The U.S. Commission of Marine Science, Engineering, and Resources in its publication, Our Nation and the Sea, states: “Mankind is fast approaching a stage when the total planetary environment can be influenced, modified and perhaps controlled by human activities.”

This means that the imaginary person at the beginning of this writing who lives in the midst of a vast desert may be unable to obtain edible fish or to vacation near the ocean. He may find his skies raining poison rather than clean water, or that man’s interference may have rerouted the air currents preventing any water at all from reaching his isolated home. Because of usurpation of our underground water reserves, our hypothetical man may even discover that the water table has dropped so low that he cannot obtain enough clean water to sustain himself. The need for everyone to know something about our waterways is paramount to our future survival.

**SEACRAFT**

Boats have been part of man’s culture since earliest times. Proof of this is that the earliest records of boats, Egyptian and Mesopotamian pictures, show an already well-developed seacraft. Common sense dictates that people who live
near large bodies of water, be they lakes, rivers, or oceans, must of necessity learn to cope with them. Failure to understand the seas leads to tragedy. Mastery of the seas, on the other hand, brings many rewards: food, drink, transportation, recreation, wealth, and power.

The first requirement of any sea-going craft, as Thor Heyerdahl points out, must be that it float. Suppose, therefore, that the first boat was a log. Lash a few logs together and you have created a raft capable of supporting tons of weight. In Kon Tiki, Dr. Heyerdahl proved that a simple raft could not only sail rivers and inland waterways, but be a seaworthy craft as well.

Peter Freuchen in his Book of the Seven Seas shows that primitive peoples all over the world had seaworthy craft. Inhabitants of the South Pacific constructed easily maneuverable balsa wood rafts and outrigger canoes; Eskimos made kayaks and larger canoe-like boats, called oomiaks, from animal skins; the Egyptians fashioned sea-worthy boats of reeds; and the Russians made large, clumsy rafts of spruce. Peoples all over the world have found ways of making sea-going craft from the materials available to them.

Although most of these craft used manpower, some of these early peoples had discovered the principles of sail and the wind-driven craft. The Egyptians, Vikings, Greeks, Phoenicians, and South Americans all used the wind to power their boats or rafts long before the time we ascribe to the large sailing ship.

Most of these craft could only sail before the wind. For that reason men also were used to power the craft. Often the men who rowed these ships were slaves or prisoners who would spend their entire lives chained to the oars they pulled.

Because human nature is not all goodness and light, it was soon discovered that the people who obtained the seas gained wealth and power of which, otherwise, they could only dream. Thus, the Egyptians, rulers of the Nile, used the labor of conquered nations to man the galleys of their warships and pleasure craft. The Greeks, who under Alexander the Great ruled the world as they conceived it, controlled the entire Mediterranean with their large navy. And to the North, Vikings with their soldier-rowed ships containing one large sail, controlled the northern seas as far west as Canada.

The era of the modern sailing ship really began in the fifteenth century with Prince Henry of Portugal. He became fascinated by the sea and in 1416 founded a school for seamen. He invited the most knowledgeable scholars from all over the world to the school. The personnel included mathematicians, map makers, astronomers, and sailors. His goal was to develop a craft hardy enough to explore the oceans without hugging the land. The result was the caravel which was, according to Peter Freuchen in the Book of the Seven Seas, “larger and slimmer
than anything yet made, carried more sail and was tough enough to withstand gales and waves at sea."

This technological achievement gave the Portuguese and the Spanish control of the seas for many years. During the course of that time Spain and Portugal divided the Americas between them and became wealthy from their trade in the East. Their first, serious challenge came from the Turks whom they demolished, and later from the British. Most students have heard of the Spanish Armada and the battle in which the little English navy destroyed the big Spanish fleet.

According to Peter Freuchen, the two navies were evenly matched in number and size of ships and in number of men. The English, however, had better trained leadership who possessed a new battle strategy and technologically improved ships, which were able to encircle parts of the Spanish fleet and pound the hulls with cannon shot.

After ten days of bitter fighting, the Spanish fleet began a retreat—north around Scotland. More Spaniards died on the flight home than in the battle, and the British had established themselves as the new rulers of the sea.

While the English battled Spain for possession of the sea, the Dutch had improved the carrying ability of their ships and had simplified the rigging, so that even Sir Walter Raleigh reported that a Dutch ship of 200 tons was able to carry goods cheaper than a British ship "... by reason he hath but nine or ten mariners and we nearly thirty." Also they "build every year near one thousand ships and not a timber tree growing in their own country." 3

Wealthy Dutch merchants formed the monopolistic Dutch East India Company and infiltrated the Spanish and Portuguese trade in the East. Their Dutch cogs rounded the Cape of Good Hope in Africa and headed for Java, where they loaded spices, fabric, and metals from the Orient. To the North the Dutch searched for the northeast route across the top of the world, founded Spitzbergen, and returned not only with furs but also with oil, bone, and ambergris from a lucrative whaling industry. These ships made Holland one of the richest nations of the seventeenth century.

The English East India Company competed with the Dutch both in the East and in the North. Eventually, the British brought India under its influence and practiced whaling in the open seas after the whales had learned to avoid the land. In time the British also dominated China's tea and opium trade and outlived its Dutch rival.

In addition to the Dutch, the Scandinavians to the north also enjoyed the prosperity of a booming fur trade and whaling industry. The Americans, not to be outdone, perfected the art of whaling and developed a shipbuilding industry along the Eastern shore.
America entered sailing in the eighteenth century and remained competitive for many decades. Americans designed the fastest sailing ships abroad for the purpose of sailing opium, slaves, or anything else that could be traded for huge sums of money. In addition to these fast-running clippers there were fishing boats, whalers, and many other boats built for special purposes. The American coast from New York to Boston contained some of the finest shipbuilders in the world.

New Haven, then as now, was a town with a strong sea-going tradition. The sharpie, a boat peculiar to the area, was an early oyster boat. In addition, schooners and ketches made their way into New Haven harbor. Some of New Haven’s first families, the Townsends for example, made their money running produce to the Caribbean to feed the slaves and returning with rum and a little slave-running on the side. Most New Haven watermen, however, were fishermen working Long Island Sound much as they do today.

In the early nineteenth century, Robert Fulton’s steam engine began the end of the era of sail and made the African and Asian continents accessible. The Europeans were able to carve up the African continent and gain entry to China and India. Steam was quickly followed by the highly efficient diesel motor which most commercial craft still use today.

One other point that needs to be mentioned is the condition of the crew on sea-going vessels. Many of our students watch “Love Boat” on television or read romanticized accounts of trips to foreign lands. Recruiting officers even today are not very honest in depicting life as it really is aboard ship: “Join the Navy and see the world.” But life aboard sailing vessels was extremely hard. It was even more difficult if the captain was hard or incompetent. Sailors had the poorest quarters, little and often rotten or moldy food, and brackish, sometimes contaminated water. More men died from illness than from the everyday hazards of the sea.

To make matters worse, when at sea, crewmen were at the complete mercy of the captain who had the power of life or death over his men. And if a man survived years at sea and managed to get home, he was often cheated of his wages. Conditions were often so bad aboard ship that captains would not put into port in order to keep their crews. Sailors were often shanghaied by men called crimps and sometimes the seamen were slaughtered or left in a foreign port near the end of a voyage for their wages or their share of the profits. In the United States, it was not until the nineteenth century, after the publication of Dana’s Two Years Before the Mast, that the first laws protecting the ordinary seaman were passed.

The change to steam engines produced little change of conditions for the seamen. Stoking the massive boilers and cleaning out the ashes and soot were hot,
dirty, and dangerous jobs. Further, the space occupied by the boilers and the fuel precluded better accommodations for the crew. The diesel engine and changing social mores allowed for improvement in living conditions for the sailors. Even today, however, stories abound of crews which have been mistreated aboard ship, and it is well for anyone thinking of signing upon the nearest tramp steamer to be wary.

THE LOG

As part of the unit’s experience students will be asked to keep a log. A log is a journal or diary where a person writes his or her impressions, thoughts, feelings, and dreams. A sailor’s log begins with observations about the weather, time of day, location, and surroundings. These writings were not just a whim on the part of early seamen. These observations were often central to a ship’s survival. Before discovery of accurate ways to determine longitude, many captains’ logs were kept secret because of the information they contained about tides, winds, currents, hidden reefs, and other dangers.

A log forces the writer to be a more careful observer of things around him as well as his inner life. In order to derive the benefits of a log, it is best to establish a routine, daily, if possible.

Because a log is handled every day, it must be quite sturdy. It is best if the pages are sewn rather than glued or threaded with spiral wire or rings because the pages are less likely to come apart. Thicker covers tend to last longer than thin, paper covers. Notebooks fitting this description can be found inexpensively or if you choose, fancier bound books are available. Students in my classes have found logs for as little as one dollar, although several have decided to buy more fancy books.

Students will be given assignments to complete in the log, but more often students may write in the log whatever pleases them. There are many things students can put in their logs:

1. Students can use the log to picture their lives, not only with words, but with pictures or colors or things students feel give an honest presentation of their lives.
2. Students can use the log to write what they think and feel are important to them. For example: What would you like to do with your future? Are people pushing you in directions you don’t want to go? How? Why? Can you change this situation? How do you feel about selected people in your life? Would you like to change them? Yourself? In what way?
3. Students can use the log to write new ideas, those that just pop into the head or those which require careful development. Students may also write new ideas that they’ve read or heard about. The student may wish to expand these ideas or perhaps create a fantasy.

4. The student may write snatches of conversations he or she thinks clever, funny, or dramatic. Many writers use this technique to preserve ideas, and a student may find something he or she wishes to use in a future story. Students can jot down jokes, family stories, the latest rhyme or poem.

5. Vocabulary is a very important tool for a writer. Write down new words and their meanings, make puzzles of the words, or put down the new words in sentences.

6. Describe people, things, a favorite room, the cafeteria at lunch time, a best friend, a favorite grandparent, the lake on a rainy morning.

7. Put real items in the log: photographs of good friends or of a happy trip, past theater ticket stubs for a terrific time, a postcard from a foreign land or a cartoon the student enjoyed. Use rubber cement as the glue so it is possible to remove or rearrange items.

8. Experiment! Try a new kind of writing, a secret code, or some unusual poetry. Bend the conventions, break the rules, and see if you like it.

In addition to giving students ideas about how to use the log, show students examples from logs or diaries. Following are some brief examples from previously printed writings.

Below is a sample from Dove by Robin Graham, just a few days after the start of his trip:

"Just took down the mainsail . . . because of a squall. Enjoyed seawater bath—poured buckets of brine over my head. Gosh it’s good to feel clean. The smell in the cabin had disappeared, so it must have been me that caused it and not the cats."

Later, when he is almost home, Robin writes:

"I can’t believe it . . . I don’t know what I really feel except that my stomach is all knotted up . . ."

In Joan Baez’s book, Daybreak, she writes about her mother:

"My mother—she can’t understand anything phony. She refuses to go to teas, prefers young people to older . . . When she runs on the beach, dressed in blue jeans and a T-shirt with her hair all down, she looks nineteen. She is fifty-four . . ."
Thor Heyerdahl writes in *Kon Tiki*:

“May 17. Norwegian Independence Day. Heavy sea and fair wind. I am cook today and found seven flying fish on deck, one squid on the cabin roof, and one unknown fish in Torstein’s sleeping bag . . .”

It is important to fix a specific amount of time each day to write in the log. The time can vary from ten minutes to one hour or more. Students should write even if they feel they’ve nothing to say. It’s important to establish the habit. The good writing will come. On the other hand, students should not be slaves to their logs either. If one misses a day here and there or if some days produce just a few ragged lines, no great harm has been done. Students should keep logbooks neat and write and draw in ink or magic marker only to prevent smudging.

I normally begin each year with regular log checks, collecting them for assignments or just reading through them, beginning at eight-to-ten day intervals and gradually expanding to once every six or eight weeks. In this way I hope to establish writing as a habit and also encourage students to continue their logs long after they’ve left the classroom.

**PRESENTATION**

There is no best way to present the elements of this unit. This unit begins with short fiction because most students are already familiar with the short story and because a suspenseful story can draw students into reading information about the sea.

Additionally, it is important that an English unit be flexible enough to blend with other units in a marine studies environment. If, for example, students are going on an orientation trip aboard a boat, that may be the ideal time to study vocabulary identifying parts of a ship.

After students’ first trip, the teacher may wish to capture students’ observations in their logs. While students are learning to use some navigational aids, the instructor may have students write instruction booklets or produce instructional films or demonstrations about the use of various navigational tools. In this unit Gallico’s “The Snow Goose” is the second story presented. If, however, students don’t study the tidal marshes until spring, the teacher may wish to postpone reading “The Snow Goose” until then.

The next section of this paper begins with samples of introductory lesson plans followed by study guides for several writings. Texts or anthologies in which
these writings can be located are listed in the bibliography at the end of this paper. Wherever possible, suggestions for other readings in the same genre are listed at the end of each guide.

LESSON PLANS

Day 1

Objectives
To introduce students to writing in logbooks.
To encourage students to think constructively about life goals.

Materials
Logbooks, pens.

Procedure
Explain that the students are to write their first entry.
Students should begin by placing the date, time, temperature, weather, and surroundings at the top of their entry. The book The Boy Who Sailed Around the World Alone contains pictures of his log that students can examine. The teacher may wish to display this and other samples of logs.

Day 2

Objectives
To share student writings and ideas.
To explore a question and express your own ideas—an introduction to exposition.

Materials
Logbooks, pens, transparencies containing presentations.

Procedure
Encourage students to share voluntarily their imaginary trips.
Discuss stories: Why did you choose to travel there? Why do you want to go? Do we sometimes want to do things without knowing why?
On a transparency, present the following:

a. Kenichi Horie sailed alone from Osaka, Japan to San Francisco in 1962. He was 23 years old at the time. When asked, “Why did you do it?” he responded in his book, *Kodoku*: “Well, I crossed it just because I wanted to. Honestly, I didn’t have any purpose or motive other than that when I decided to sail across the Pacific. But none of these people were able to understand this.”

b. In *Moby Dick*, Ishmael says: “Whenever I find myself going grim about the mouth, whenever it is a damp, drizzly November in my soul . . . whenever . . . it requires a strong moral principle to prevent me from deliberately stepping into the street and methodically knocking people’s hats off—then, I account it high time to get to the sea as soon as I can.”

Ask students their thoughts on each quotation. Allow a few minutes discussion. Assignment: Why is it hard for a person to explain why they want to go to the sea? Are they hiding something from others? From themselves? Why would going to sea help Ishmael? Did you ever want to change the routine of your life? If so, what were your reasons for desiring a change? Did you get a chance to get away? Where did you go? Did the experience change you? How? Ask students to express their feelings about these questions, then to write about a time they wanted to go away. Students may choose an alternate experience of explaining why Ishmael yearns for the sea. Length: 150-200 words.

Students will be reading several stories in which an individual decides to go to sea. Students should always look for the reasons a person begins an adventure.

**STUDY GUIDES**

**Fiction**

Short story: “Sea Devil,” by Arthur Gordon

“Sea Devil” tells of a man whose name we never know, but of whom we learn that he likes to fish at night, because “he found in it a reality that seemed to be missing from his twentieth century job and from his daily life.” He fishes by using a cast net. On one particular velvety Florida night, he casts his net only to have the sea “explode in his face.” He has ensnared a “Sea Devil”—a large manta ray—in his net and because the net is attached to his wrist, the man finds himself suddenly dragged into the ocean, and struggling for his life. How he survives, and he does survive, is told in stirring descriptions which lend themselves to being read aloud. As a result of his experience, the man learns something about his relationship with nature which changes his life.
Questions:

1. Why does the man like casting alone at night?
2. The man is described as a person who “Worked with his head, not with his hands.” Is it his head or his hands which finally saves him? Tell how he saves himself.
3. At the beginning of the story, the author says, “He liked being the hunter, skilled and solitary, and elemental.” But at the end of the story the man sets a captured mullet free. Why?
4. In this story, how does the setting add to the conflict and the tension?
5. At the end the man thinks, “He knew he would do no more casting alone at night . . . No, not he.” Why?

Log Assignment: Have you ever been in a life threatening or in an emergency situation? Tell about it. Use words of action, color, size, shape, and feel. Tell how the situation was resolved.

Vocabulary: Before students begin reading, acquaint them with the following words. The teacher may have students write definitions and sentences or complete the small exercise which follows the words.

bay  lagoons
sea wall  roe
skiff  moored
atavistic  retrieve
gunwale  channel
port-starboard  bow-stern
tenaciously  pinioned
respite  imminent
doggedly  pilings
ebb

Matching Exercise: Write the letter of the word or group of words which has the closest meaning to the first word.

1. lagoon: (a) large ocean (b) grassy plains (c) desert (d) lake of brackish water
2. sea wall: (a) barrier to prevent beach erosion (b) a kind of fish (c) barrier to prevent swimmers from going out too far (d) sea area where the heavy density of fish prevent navigation
3. roe: (a) small boat (b) fish eggs (c) young mullets (d) seaweed
4. skiff: (a) sharp wind (b) to run away from (c) small flat-bottomed boat (d) sailor’s hat
5. moored: (a) rowed slowly along the shore (b) stuck in mud (c) tried to signal location (d) secured a boat to shore

6. atavistic: (a) throwback to the primitive (b) antagonistic (c) trying to accomplish the impossible (d) understanding how others think

7. channel: (a) short, simple song (b) tall building (c) deep, navigable passage (d) thin, narrow ship

8. tenaciously: (a) uncertainty (b) doggedly (c) completely (d) precariously

9. pinioned: (a) hemmed shirt or pants (b) asked someone’s opinion (c) nailed a board (d) held in place

10. imminent: (a) about to occur (b) very famous (c) dangerous (d) to be happy

Project: Locate information about the ray described in this story. Draw a picture and describe the ray’s habits. Are there other members of this family? Are they as frightening as this story depicts them? Design a bulletin board using the information you’ve collected.

Poem: “Carmel Point,” by Margaret Phyllis MacSweeney

In this poem the speaker witnesses a “daring” young crab eaten alive by a beautiful, soft flower-like sea anemone. The speaker runs to his or her father and tells him that he or she is “sorry to be born” because he or she is frightened by so many things. The imagery in the poem is quite beautiful and at the same time menacing. The poem uses personification portraying the anemone as a woman.

Questions:

1. Why is the speaker horrified to see the anemone eat the crab?
2. What aspect of this occurrence makes the speaker afraid?

Log Assignment: Have you ever seen anything that frightened you? Describe what you saw. Describe the colors, sizes, shapes, smells, and feelings of the time. How did you feel as you watched? What did you do afterward? When did you first realize you were afraid? Did this experience change you in any way?

Project: There are many kinds of sea anemones. Design a story board or a series of slides with pictures of various anemones. Write a dialogue in which you describe the plants, their habitat, and their life cycles.

Poem: “First Lesson,” by Philip Booth

In this poem a father comforts his daughter during her first swimming lesson. The poem flows rhythmically and visually like the waves in the ocean. The
speaker encourages his daughter not to float “face down” but when afraid to “lie back” and let the waves “hold you.”

This poem, like “Carmel Point,” uses the sea to express a viewpoint about living. It is an optimistic poem with a lesson about riding with life. Have students reread the last five lines of the poem and talk about what they mean.

Log Entry: How can the last five lines of the poem be applied to life generally. Give an example from your life to show how this advice could be used.

Project: Write and illustrate a poem of your own about a “First lesson” you had. It does not have to be about swimming, but could be about a first day at school or a first party or the first boy or girl you dated. Think about the first time you did something or realized something, and fashion your own poem.

Novelette: *The Snow Goose*, by Paul Gallico

*The Snow Goose* is a short novel which takes place in England from 1930 to 1960. Rhayader, hunchbacked and with a misshapen arm, resides alone in an old lighthouse amidst estuaries which he has shaped into a wildlife preserve. One afternoon, a young girl, Fritha, comes to his home carrying a wounded large white bird. Rhayader helps the bird, a Canadian snow goose, and the bird and the girl become regular visitors to the lighthouse. Years pass and the girl and the bird grow to adulthood.

During this time Rhayader and Fritha have grown to care for one another and share a mutual regard for the wildlife which surrounds them.

World War II erupts and Rhayader attempts to enlist but is rejected due to his deformity. Then in 1940 British men are stranded along the shore in the Battle of Dunkirk. A general call is issued for anyone possessed of a boat to go in under fire and rescue the stranded soldiers. Rhayader goes, despite Fritha’s protestations, valiantly rescues many men, and is killed. The snow goose returns to Canada, and Fritha continues to care for Rhayader’s birds until the lighthouse is bombed by the Germans. The sea regains the land and the estuary becomes barren and desolate.

Although sentimental, the story is simply and beautifully told. It’s easy to see the similarities between Fritha, Rhayader, and the snow goose, and students will respond to Rhayader’s courage. Students will also learn something about the relationship of man to nature and about the destructive manner of war to all things.

Questions: Chapter 1

1. What is the setting of the story? Describe it.
2. Why had Rhayader gone to live in the lighthouse?
3. Describe Rhayader’s personality. What skills does Rhayader possess?
4. What brings Fritha to the lighthouse? How does Fritha react to Rhayader at first? Later?
5. The author says that Fritha reminded Rhayader of wild water birds. What does he mean?
6. When the snow goose leaves, Fritha also leaves. How does Rhayader react to her going?

Chapter 2

1. Why was Rhayader surprised when the snow goose returned?
2. What did Fritha learn from Rhayader?
3. How did Rhayader react the summer the bird did not return?
4. The year the bird returned, it was full grown. Compare the bird with Fritha.
5. How does Fritha feel about Rhayader now? How do you know?

Chapter 3

1. In spring 1940, when the pink-feet geese migrated, what did the snow goose do?
2. How did Fritha and Rhayader react?
3. How does Rhayader explain his going to Dunkirk in his little boat?
4. Why does Rhayader tell Fritha she can't go with him? Who does go?
6. Why do you think it was important to Rhayader to go to Dunkirk?
7. What effects does war have on people? The land? Wildlife?

Log Assignment: Are there ever reasons to go to war? If so, what are they? Explain and use examples. If not, explain.

Projects

Find information about the wild birds mentioned in the story. Draw pictures and write brief reports of their habits and lives.

Read about the battle of Dunkirk. Report to the class the happenings, results. Use pictures or slides to aid your report.

Design a bulletin board about the Canadian snow goose. Show pictures, patterns of migration, life cycle.

Read about and describe the effects of war on nature. Illustrate your report with photographs and eye-witness accounts.
Across

2. low part of a river influenced by tides
4. with suspicion
6. land covered at high tide and exposed at low tide
7. small bodies of water remaining after ebb tide
8. adroit, dexterous

Down

1. still exists
3. face
5. was next to

Vocabulary:

1. mud flats
2. tidal pools
3. estuaries
4. bulwark
5. encroaching
6. breached
7. abutted
8. beacon
9. garnered
10. askance
11. visage
12. pinioned
13. extant
14. uncompromising
15. deft
Play: The Caine Mutiny Court-Martial, by Herman Wouk

Lieutenant Stephen Maryk is being court-martialed for relieving his superior officer, Commander Philip Francis Queeg, of his duty during the course of a storm. Because this breach of the law occurs during World War II, Maryk's life is at stake. He is being defended by Lieutenant Barney Greenwald at the request of the prosecuting attorney, Lieutenant Commander John Challee. Challee has requested Greenwald to take the case because he recognized his friend as a fighter for lost causes.

At first Maryk has little faith in Greenwald. Greenwald has expressed his view that he'd rather prosecute Maryk than defend him. Greenwald refuses to tell Maryk the plan for Maryk's defense. When Maryk asks him why he took the case, Greenwald explains that he is the only person who can free Maryk.

Maryk decides to gamble and the trial begins. Various witnesses tell of the conditions aboard ship, the storm, and the ship's takeover. The trial is masterfully presented as Maryk's witnesses are shown to be scheming, idiotic, or unknowledgeable. Greenwald realizes that the only way to save his client is to prove Queeg incompetent. This he does by skillfully manipulating Queeg and bending the legal system. Maryk is acquitted but at the expense of Queeg's career.

At a victory celebration Greenwald surprises everyone by demonstrating that Lieutenant Thomas Keefer, a novelist and supposed friend of Maryk, engineered the takeover and that Queeg, for all of his unpleasant eccentricities, had a noble side. He was there when the war began, or, as Greenwald puts it, he kept "Mama out of the soap dish."

Students must understand a little about World War II and the navy regulations in order to understand the play. Once that is accomplished, they should find the play easy going. Because this play is simply staged, have the students act it out. Because each character is so distinct, students will gain much from watching the actions. Have the student take turns directing various scenes.

In this play is a variety of conflict. It exists between persons, between the individual and the institution, and between the reality of life versus the ideal. The question, "Is there a time to go to war?" is again raised. There is enough conflict to encourage excellent discussions.

Questions: Act I

1. What kind of man is Greenwald? Why does the writer spend so much time on him during scene 1?
2. Describe Maryk.
3. Of what is Maryk accused? What is the penalty if found guilty?
4. What is Maryk’s attitude toward Greenwald at the beginning of the play?
5. What is Maryk’s attitude toward defending Maryk? Why?
6. Why doesn’t Greenwald want Keefer on the stand?
7. What is Blakely’s role at the courtmartial? What are his attitudes toward Greenwald at first?
8. Why is Blakely surprised when Greenwald says he’d call Queeg for the defense?
9. What did Greenwald mean when he said, “You don’t understand, do you? Not about Keefer. Not even about yourself?”
10. Why was Urban an unsuitable witness?
11. What did Greenwald mean when he said to Maryk, “Implicating Keefer harms you”?
12. Did Keith’s testimony help or hurt Maryk? Tell why or why not.
13. Why is Lundeen’s testimony important?
14. Lundeen said that Queeg “revises reality in his own mind so that he comes out blameless.” What evidence can you find to support the truth of that statement?
15. Why does Greenwald keep emphasizing the word paranoid?
16. How did the way Greenwald questioned Bird affect Bird’s testimony?
17. Was the outcome in scene 1 in Maryk’s favor? If so, when did it begin to change?

**Act II**

1. Why does Greenwald want to know if the Caine was in the last extremity when Maryk relieved the captain?
2. Why did Maryk keep a record of Queeg’s mental health?
3. Is there a change in Blakely’s attitude? What brought that change about?
4. Explain the “strawberry” incident.
5. What holes in Maryk’s story does Challee uncover?
6. Why was Maryk stunned when his testimony was over?
7. Why did his testimony and Queeg’s differ?
8. When did Queeg’s testimony begin to show that he was not completely truthful?
9. Why did Greenwald threaten to subpoena Langhorne?
10. Challee says that Greenwald is turning the trial into a courtmartial of Queeg. Do you agree with Challee? Explain.
11. When does Queeg begin to crack on the stand? How do you know?
12. How does his long speech affect his audience?
13. Why is Challee angry with Maryk?
14. Why did Greenwald defend Maryk?
15. What did Queeg’s responses during testimony suggest about his reactions during the storm?

Act II, Scene 2

1. What reasons did Greenwald give for bending the law? Do you think he was right or wrong? Explain.
2. Why does Greenwald make a hero of Queeg?
3. Why does Greenwald say that Keefer is really the guilty person? Why doesn’t Greenwald like Keefer?
4. Why does Greenwald get drunk?
5. Explain Greenwald’s attitude when he says to Maryk, “See you in Tokyo, you mutineer.”

The Play as a Whole

1. The theme is the message of a story. What do you think the theme of this play is? Give reasons.
2. What is the importance of Greenwald’s mother to the play?
3. What is the climax of this story? Explain.
4. What are Greenwald’s feelings about the Navy?
5. Who do you think was the most admirable character in the play? The least? Give reasons for your answers.
6. Part of this play lies in determining what is the truth. How did the testimony of each character aid in determining what really happened?
7. Do you think Maryk should have been found innocent or guilty? Why?
8. Did Queeg receive a just verdict? Explain.
9. What were Greenwald’s motives for defending Maryk? Explain.
10. The way in which the play is told served to make it more interesting. What did you like about the play? Explain.

Projects
1. Construct a diorama of the set.
2. Analyze the following characters. What made them tick?
   a. Lt. Barney Greenwald
   b. Lt. Commander Philip Francis Queeg
c. Lt. Thomas Keefer

d. Lt. Commander John Challee


4. Read about World War II. Gather pictures and keymaps. Form a committee and present your finds to the class. Afterward form a panel discussion.

5. Find someone who participated in WWII. Interview them and take their stories. Gather pictures if possible. Tell their story to the class or bring the person to class and present the story.

6. What effects can absolute power of a captain have on a crew? Research and write a paper of actual incidents which featured in some way the total power of a commander at sea.

7. Research World War II ships. Draw or build models of three ships and explain how each ship functioned.

8. Explore the nature of justice. Is justice always served by following the letter of the law? Write an essay in which you present your point of view and support your ideas with examples.

Non-Fiction

Narrative: Dove, by Robin Lee Graham

At sixteen years of age and already an experienced seaman, Robin Lee Graham yearns to see the world. He wants to run away from school, regimented civilization, and the crowded, polluted cities in which he has lived. He wants to do something different, special, and totally his own.

Robin’s father, fearing dread consequences of his son’s restlessness, buys and outfits Dove, a 24 foot fiberglass sloop. And on July 27, 1965, Robin begins his trip, alone, around the world.

In his book, also called Dove, Robin recounts his adventures. As he sails from island to island, Robin tells of the wonderful people he meets and their customs. He describes his battles against stormy seas and his struggles with loneliness during calms. During this five year voyage, Robin also meets his future bride, but most importantly he tells how he grows as a person.

This book is more modern than some of the around-the-world-alone adventures and should be easy to read because it is told in a straightforward manner. It is a book with which most teens can identify because Robin is a very ordinary boy who has the same feelings about school, adults, love, and the world that most students have.
Questions: Chapters 1-4

1. Why does Robin Lee Graham want to go to sea?
2. Describe his attempt to go to sea in the HIC. Why do you think they survived?
3. What effect did the HIC have on Robin's father?
4. On the first leg of Robin's voyage he says, "The voyage to Hawaii was almost too easy." What does he mean? Do you agree?
5. Robin's uncle gave him two kittens whom Robin names Joliette and Suzette. Throughout the voyage Robin carried pet cats. Why?
6. How did Robin cope with the loneliness he often felt?
7. When Dove first loses its mast Robin says that "What separates the men from the boys is the emergency moment that might never happen again." What does he mean?
8. After Pago Pago, Robin lands in the VaVau group of islands which he describes as the friendliest. Why does he feel that way?
9. In Fiji Robin has difficulties for the first time. Why? How does he solve his problem?
10. Would Robin agree with the following statement: "All South Sea islanders are the same"? What would he probably reply?
11. How does Robin meet Patti Ratterree? How does he help her?
12. In the Yasawas Robin and Patti become lovers. What characteristics of Patti did Robin admire? How did the atmosphere of the islands contribute to their happiness?

Chapters 5-8

1. What part does National Geographic play in Robin's trip?
2. How do Solomon Islanders feel about Americans? Why?
3. On his way to Darwin Island, Robin experiences a storm and also several days of becalmed seas. How did he respond to each situation? Which was easier? Why?
4. a. How do Robin's relatives respond to the news about Patti?
   b. What does Robin decide to do as a result?
5. On the way to Mauritius, Dove lost its mast a second time. How did Robin handle this situation? In what way was he careless?
6. On the way to Durban, Dove almost foundered in a storm. How did Robin react? What was he thinking? What did he do?
7. What were some of the difficulties Robin and Patti experienced when they wished to marry? Why do you think Robin's parents changed their minds?

8. Why was crossing the Atlantic difficult for Robin?

**Chapters 9-13**

1. Why does Robin decide to sell Dove and get a new boat? What does he name the new boat?
2. How does Robin react to the news that he's about to be a father? Why?
3. Robin says the hardest leg of his journey was the 2600 miles from Galapagos to Long Beach, California. What made this leg of the journey difficult?
4. How did Robin feel on his way into Long Beach Marina?
5. What is his response to the attention he received from the media?
6. How have the Grahams decided to live now that the trip is over and the baby born? What are their reasons?

**The Book as a Whole**

1. Why did Robin make the voyage?
2. How did the loneliness affect him?
3. What were the most difficult parts of the journey? How did he react to these challenges. What kept him going? Why did he survive?
4. What were his feelings about the sea? Did they change? How? Why?
5. Did Robin grow as a person through this experience? Why?

**Projects**

1. Design a model of Dove I or Dove II. Label the important parts of the ship.
2. Select one of the countries Robin visited. Go to the library and find out as much as you can about the country.
3. Have you visited any of the places where Robin stopped? Tell about your experiences in that country. If you have slides or pictures, include them as part of your report. You can design a slide-tape show if you wish by recording your feelings about each slide or picture.
4. One of the places Robin visited was the Galapagos Islands. Much study and research have been devoted to the wildlife there. Read about it and make a report.
5. Plot Robin's course on a large map or design the map yourself, plotting his course.

6. Read about other people who have circled the world alone. Compare their voyages with Robin's. Write about the things that were the same and those which were different.

7. If you were to circle the world, not necessarily alone or by sailboat, where would you stop and why?

8. Loneliness seemed to be a real problem to Robin. There have been cases of people who went mad alone on the seas. Do you think you could circle the world? What would you do to combat the loneliness?

Vocabulary

1. sloop
2. slip
3. mainsail
4. mast
5. jib
6. jibing
7. harbor
8. keel
9. boom
10. rigging
11. ketch
12. buoy
13. tiller
14. spray
15. genoa
16. comber
17. chronometer
18. barometer
19. compass
20. sextant
21. longitude
22. latitude
23. doldrums
24. draw (as in "she drew 4 feet")
25. cockpit
26. gunwale
27. step (as in "to step the mast")

Exercises

1. The teacher can divide the class in half, giving each half 15 words to look up, writing down the definition and a sentence for each. When the sentences are finished, the teacher selects a word and each student writes his sentence for that word on a transparency. The following day, the class examines all the sentences for a given word and decides which are good sentences. Students then select good sentences to put in their logs for vocabulary study.

2. A student makes a line drawing of a ketch or a sloop. Students then label parts of the diagram using words from the vocabulary.

Matching Exercise: Match the letters on the right side with the correct words on the left.
1. sloop a. instrument used to measure altitudes of celestial bodics
2. ketch b. backbone of a boat to which frames are attached
3. chronometer c. ship of two masts with the mast closest to the bow taller than the main mast
4. comber d. single-masted fore and aft rigged sailboat
5. spray e. instrument used to measure atmospheric pressure
6. keel f. float moored in water as a marker
7. jib g. mass of dispersed droplets from a wave
8. sextant h. triangular sail stretching from the fore mast to the bowsprit
9. buoy i. a long cresting wave of the sea
10. barometer j. extremely precise timepiece

It should be noted that there are several other books about people who have sailed alone. I have found all of these stories interesting as the people involved are rather eccentric individuals:

1. Sailing Alone Around the World, by Captain Joshua Slocum
2. Gipsy Moth Circles the World, by Sir Francis Chichester
3. Tinkerbelle, by Robert Mandry

Notes

1U.S. Department of the Interior, River of Life, 7.
2Wesley Marx, The Protected Ocean, 8.
3Alan Villiers, Men, Ships, and the Sea, 140.

Annotated Bibliography


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American Detectives: 
On TV and in Books

Jane K. Marshall

This unit was written as a final chapter for a book I have prepared based on units written during my eleven-year affiliation with the Yale-New Haven Teachers Institute. The book, *The Eyes Have It: Exploring Literature and History Through the Visual Arts*, provides a sequence of study which I use in a course simply called “Visual Art and Literature.” This course enables students to acquire analytical skills; to perceive the visual arts, as well as literature, in historical or cultural contexts; and/or to realize the notion of individual and cultural discovery. I teach the course currently to a mixed class of college-bound and work-bound seniors, although I have used various parts of the program with younger high school students, and I have also taught the entire course to college-bound juniors.

“Visual Art and Literature” comprises a two-period-a-day semester-long program. Students consider the visual media of painting, photography, film, and television drama along with literature. For example, a comparative look at painting and poetry reveals that both forms of art manifest such elements as mood, metaphor/symbol, and pattern. Often visual and written works of art are paired in “Visual Art and Literature” so that students are provided with two keys, as it were, to the understanding of particular cultures. Students learn how to approach various media through a study of a material culture method of analysis developed by Jules Prown (Paul Mellon Professor, History of Art, Yale University). They also learn about various elements of particular art forms and the relationship between these elements and the tools used by the poet and the fiction writer. For example, in the film chapter, “America in Film and Fiction,” students consider point of view as a technical and thematic topic in a concurrent study of film and the short story.

“American Detectives: On TV and in Books” deals with the notion that popular works reflect the concerns, beliefs, and dreams of particular societies.
Through engagement with detective stories and television programs of varying times and places, students are encouraged (once again as in preceding units) to discover "social history."

The practice of extended engagement with what audiences usually accept at face value also enables students to note and ultimately to question the validity of the assumptions of story-tellers—evident in stereotyping, for example. Students then become true critics of the popular culture which to a certain extent envelops us all—learning to break through the complacency of acceptance: "This is the way things must be," and, one hopes, discovering the possibilities in their roles as consumers of popular myths.

Although "American Detective: On TV and in Books" works well as the last chapter of The Eyes Have It, for it follows cultural discoveries made through studies of painting, photography, and film, I believe that it could be taught fruitfully as a single unit. "American Detectives" in essence deals with the inherent problems associated with the use of video material in the classroom. Who among us has not been disappointed with the results of the "film version" activity (following the reading of a novel)?

Such a concluding activity seems appropriate, yet though the students are encouraged to weigh the merits of the books and films respectively, all too often the resultant discussions are desultory and forced. Experience tells me that only the most sophisticated of high school classes will view film versions seriously and critically.

I suspect that students often see the film version activity as a reward for reading accomplished or as a break from the rigors of English class. This reaction is exactly antithetical to the original purpose, for the message as received by students, though not the intended message, to be sure, undermines both the entertainment value of reading and the seriousness of film study. In other words, with the concluding film version activity, old prejudices may well be reinforced; i.e., "reading is work, film-viewing is fun." Certainly reading detective fiction need not be regarded as a chore, and students can be taught to view films/TV critically. Clearly, some experimentation is in order.

Given the difficulties of teaching film versions mentioned above, one might question the notion of using such video material at all. While it is true that I have seen little in the way of outside reading material in the possession of my students, and while it is also true that I would love to be instrumental in seeing to it that by students becoming "hooked on" detective fiction, I am faced by an even larger truth: many of my students have been raised on "Sesame Street," not Winnie the Pooh. The Hardy Boys and Nancy Drew were introduced to them, not in books, but through the powerful medium of television. As a result of years
of television exposure, my students know many of the characters I met through detective fiction series: Spenser, Hawk, Perry Mason, Hercule Poirot, Jane Marple, Travis McGee. The list goes on and on.

A quick perusal through a current TV Guide quells any notion that detective stories might be on the wane on TV while on the rise in written form. Detectives and their stories are enormously popular; they hold a piece of the prime time action virtually every night of the week. Though I am not a fan of TV and especially not an advocate of "Sesame Street" (which moves too fast, so that young children are actively steered away from the notion of reflection) I suspect that, given the right emphasis, the medium of television might paradoxically be used to promote reflection and even reading.

I use current and not so current television fare during the course of this unit. Initially, these television shows serve to introduce characters and the structure of the detective story to students. Because many of my students are non-readers, the prospect of a new book in English class often precipitates student anxiety. Though they are cautioned that the first twenty pages or so of a novel often provide introductory material regarding characters, setting, and form, we inevitably dance around the "this is boring" scenario until the novel is well under way. Providing students with introductory material in the form of TV shows lessens their anxiety and keeps my temper in check.

More important, television shows such as "Perry Mason" and "Spenser: for Hire" are viewed seriously. That is, students are encouraged to analyze these shows with respect to their places in time. For example, we are able to discern the values, concerns, and/or preoccupations of the late '50s/early '60s by asking the right questions of the "Perry Mason" re-run.

Essentially this unit is organized along a time line. Students view and read of Perry Mason, Virgil Tibbs, and Spenser in that order. The pairing of the television show and novel (with the television show usually coming first) leads ultimately to a critique of each medium. Television is not "run down," and students are encouraged to assess seriously each medium with regard to entertainment value and educational usefulness. The right questions have to be posed, and I have to watch carefully lest my own prejudices get in the way. Yet, I believe that the visual and written pairings lead to all sorts of discoveries about television, novels, and ourselves.

All of the shows viewed and the novels read are American. I am most interested in looking at the development of the American fictional detective over time. These figures are always in some sense both heroic and mundane, and therefore, it seems to me, reflect both what we are and what we long to be at any given juncture. Of course, it is most interesting to assess the television and novel
renderings of character. If differences are especially discernible, we must ask ourselves why this is so.

The pairings to be studied in this unit are as follows: Perry Mason re-run / The Case of the Spurious Spinster, by Erle Stanley Gardner; “In the Heat of the Night” (current TV) / In the Heat of the Night, by John Ball; “Spenser: for Hire” (current TV) / Mortal Stakes, by Robert Parker.

It should be stated at the outset that the books considered in this unit vary in terms of merit. All have some merit, of course, but certainly some works are superior to others. Perhaps providing students with a cross-section of the genre, or including stellar and not so stellar examples of writing, enables them to begin their own process of fiction/writing assessment.

Largely because of my own experiences as a high school student, I have concluded that popular literature has a place in the classroom for several reasons: 1) it is usually accessible to students 2) much of it is worthwhile 3) asking students to assess both the entertainment value and the educational value is fair game. I believe that the assessment exercise is satisfying to students, and yields interesting results for all concerned. All of the books in this unit might be labeled “popular.” That is, all have sold reasonably well to fairly large audiences. As most reflect a particular time and/or place in our culture, we might consider, as a concluding activity, the idea of popular tastes. How have tastes changed over time? Why?

What follows are fairly brief critiques of the paired television shows and books. These critiques provide the reader with an overview of salient themes which emerge through both content and style. Questions which might help students to discover the social-historical significance of such works are included as are questions or topics which might aid students in forming their own critiques of these novels and television shows.

PERRY MASON

While one is reading Erle Stanley Gardner’s work or viewing the Perry Mason television program, one is immediately struck by the formality of the character of Perry Mason. Like Sherlock Holmes and Nero Wolfe, Perry Mason is essential cerebral and/or emotionless. He has no personal life—no wife, no close friends, and his relationship with his subordinates, Della Street and Paul Drake, is merely professional. One wonders why Paul and Della (like John Watson before them) are so eager to support this rather cold and asocial man, for they are essentially used by Mason as, albeit sophisticated, errand people. Moreover,
they are never trusted with Mason's musings until a case is over, and are made to look foolish time and time again.

Some might conclude that Gardner was working in the tradition of Sir Arthur Conan Doyle. That is, his detective, like Holmes, was deliberately created as a loner for the sake of the surprise ending, and/or that Mason must remain enigmatic or tight-lipped until the end of the story lest the puzzle be spoiled. Though I do not dispute such conclusions, I also believe that such a character reflects his time.

I suggest that the formality of Mason, along with the lack of any interior monologue (thought) among any of the characters, and Gardner's heavy emphasis on plot, serve to underscore a time of isolation, duplicity, and/or frantic action, and paranoia. Perry Mason is enigmatic, for he trusts no one. Characters whose thoughts are never shared remain estranged not only from each other but from the reader as well. The result of such deadening isolation, and ironically also the precursor to increased isolation, are conditions of fear and duplicity. In other words, with his work, Gardner creates the image of an isolating and paranoid world—a world which paradoxically seeks to counteract the effects of duplicity with increased experimentation in duplicity. It seems to me that both the television show and the novel, The Spurious Spinster, concern themselves with such themes.

“Perry Mason” television show

The theme of duplicity is played out in any number of ways in the television show. Characters include a bigamist who is also a blackmailer, and an ex-convict who has taken on the identity of a handy-man so as not to embarrass his supportive and socially prominent brother. When the bigamist turns up dead, it would seem likely that he had experienced many a blackmailer's end. Yet, a friend of his young wife is framed for the killing. We learn early on that this unfortunate woman had learned of the bigamy, and thus was put in the unenviable position of needing to prove such allegations. Luckily, she had consulted Mason when she felt her life was threatened by the bigamist, for when he is found dead virtually all of the physical evidence points to her as the killer.

This rather convoluted plot, complete with the red herring of blackmail, ends with evidence of yet another duplicity—and perhaps the most unsettling of them all. We eventually discover that the husband was killed by his wife, and that it was she who arranged to have her friend framed for the murder. Such a denouement is especially bleak, for it raises all sorts of questions about friendship and trust.
Why is this woman, the essential innocent, used in such a way by a friend? By extension the viewer might ask: Whom can I trust? Could I, as an innocent, be so easily trapped and (nearly) lost? Such questions underscore a theme put forth by Gardner: Modern society, that is, the society of the late '50s and early '60s, breeds selfishness, duplicity and isolation. Can paranoia be far behind?

This sense of paranoia and/or the acceptance of duplicity as a given, which the television show hints at, becomes understandable when one thinks about the time period of the late '50s and early '60s or when one recalls the Cold War, nuclear weapons build-up, and the myriad political scandals and assassinations of the time—as an aside it is interesting to note that the years of the late '50s and early '60s are often portrayed nostalgically in current films and television shows. Perhaps we choose to forget the difficulties of the past because our own preoccupations seem essentially “new.” Yet, the evidence of the Perry Mason show points to the continuum of preoccupation with the lost values and alienation depicted in the current film, “Wall Street,” for example.

When viewed as an allegorical image of the late '50s, the Perry Mason show too speaks to a loss of values, trust, and to a diminished confidence in modern man's ability to govern himself or find happiness and peace. To be sure, there is a Perry Mason to sort out the particular conundrum, but there is also the realization that such a plot will be played out time and again, or that there is no real solution to the essential dilemma put forth. Perhaps we can take comfort in the notion that each generation recognizes its problems and is outraged enough to call attention to them through popular culture. In other words, though detective stories are often bleak, they do not advocate complacency or nihilism, but rather restate the problem with the hope that someone will take notice.

**The Case of the Spurious Spinster**

Like the television show discussed above, *The Case of the Spurious Spinster* involves the set-up of an innocent woman, and once again this woman is framed for the murder by another woman. Through an elaborate scheme of embezzlement, which leads inexorably to kidnapping and murder, a governess manages to tap into her employer's company so as to gain the necessary funds to escape her dreary existence. Once again, Mason is able to work through the mire of duplicity and false personae in order to save the innocent (and remarkably foolish) young woman in distress.

What makes this novel especially interesting is a subthematic and/or its portrayal of women and their then changing roles in society. Gardner gives us views
of several women in the business world, not very flattering views to be sure, but enlightening views all the same; we are privy to Gardner’s (and society’s) concerns about the emergence of corporate women in the early ’60s.

The Case of the Spurious Spinster is in form remarkably like the television show. Plot is paramount. Full character development is not attempted. We are not given even a glimpse into the private lives of Perry Mason and his entourage, nor are we allowed to see the perpetrators of the crimes and their victims in any setting save that of the business world. These characters thus remain types. In particular, Gardner created caricatures of various types of women in the world of work.

He offers, for example, Miss Corning, who, as head of a corporation, falls victim to embezzlement and attempted murder. She is tyrannical, arrogant, rude, and often described as “mannotish.” She does not see things too clearly. Lest we miss that point, Gardner makes her literally near-blind. In one sense she is the “spurious spinster” of the title, for we learn that, strident voice notwithstanding, she is not in control of her company or herself; far from being the imposing force she wishes to project, she is, in fact, easy prey or essentially weak. One might speculate that this rendition of a woman in power reflects a concern of Gardner and society, i.e., would women placed in positions of power turn “mannish,” yet remain essentially weak?

It is interesting to note that the two women perpetrators who engage in embezzlement, kidnapping, and murder, do so in order to escape from what might be described as feminine jobs and/or employment which requires workers to perform nurturing roles. (One woman is a governess; the other is a nurse.) These modern-day Lady Macbeths are clearly obsessed with the procurement of power and stop at nothing in their attempt to rule actively over others rather than remain in positions which imply a passive support of others. Their obsessions result not only in a loss of the nurturing quality associated with women, but also in the loss of the basic human qualities of compassion and dignity. With their acceptance of the “dog eat dog” credo, these women exhibit what some might call the animalistic reaction of killing when cornered or crossed.

Clearly, this story, like many others, illustrates a madness often associated with quests for power. Perhaps more important, these particular characters encourage the reader to question the notion of feminine and masculine roles in society. These women certainly do not fill the stereotypical view of women as society’s nurturers. One wonders whether the pressure for conformity to the stylized version of womanhood caused a heightened aggression in these women and/or led ultimately to expressions of obsession and madness. One might speculate that Gardner and the society of the early ’60s realized that “ready or not”
women had to be allowed some autonomy or choice of workplace; or perhaps they simply asked the question: Might failure to recognize and accept the notion of women's changing attitudes toward work prove more disastrous?

With the characterization of Mason's client who is neatly framed for embezzlement and murder, Gardner presents yet another type of working woman. Sue Fisher is an excellent secretary who is loyal to her employer. She is intelligent and able to make decisions on her own. Ironically, it is her ability and willingness to go beyond her duties as an office worker which land her in trouble. The perpetrators of the crimes can count on Miss Fisher to act quickly on behalf of her boss and company, and therefore they can easily place her in seemingly compromising conditions.

Miss Fisher's naiveté regarding the seamier side of the business world is a handicap which nearly deprives her of her reputation and her freedom; were it not for Perry Mason, she would most certainly be lost. Mason, who is wise in the ways of dark motivations, and is a puzzle-solver extraordinaire, does his utmost to protect Sue Fisher. His is a paternalistic stance which conveys the message: "Do what I say, and do not ask any questions." When, inevitably, Miss Fisher fails to follow Mason's instructions, she immediately puts herself in jeopardy.

Today's reader might find Mason's paternalism toward and power over women unacceptable. Yet, it seems to me that, in one sense, Gardner was simply attempting to illustrate the complexity of the business world. Miss Fisher, the essential innocent, must learn of the darker side of human behavior while she accepts the guidance of one well-versed in corruption and duplicity. Put another way, Gardner portrays the modern world as complex and dangerous; failure to recognize and do battle with one's enemies results in destruction. Though Gardner's depictions of women in the business world seem at best dated, and at worst patronizing, today, The Case of the Spurious Spinster serves to illustrate the concerns and assumptions of the early '60s. As a "living" bit of social history, perhaps it cannot be faulted.

Some Questions for Students:

1. What qualities enable Perry Mason to win his cases?
2. Why is Perry Mason portrayed as a loner (no family, no close friends)?
3. Compare the character of Perry Mason with other '50s men portrayed in television re-runs. As a stereotype of a successful man of the late '50s, what qualities of Mason's are stressed? How is he different from '80s detectives portrayed on television?
4. Give examples of duplicity in the television show and novel. Do such works reflect the real dangers of modern living, or do they exaggerate the
condition of man's isolation and/or the dangers of trusting? Do these works portray a paranoid world? If so, to what purpose?

5. How are women portrayed in the television show. Are they dominated by men? If so, in what ways? Are they different from women portrayed on television today? Explain.

6. Why does the author create types rather than full-blown characters in *The Case of the Spurious Spinster*? Describe the types portrayed by Miss Corning, Susan Fisher, Elizabeth Dow, Cindy Hastings.

7. Why is the focus on women in the business world? What point(s) does Gardner make about women's roles in society? Might an '80s author make the same point(s)? Explain.

8. How did the clothes worn by the characters in the television show reflect the time period in question? (Compare with clothes of today.)

9. Compare the plots of the television show and the novel. Which was more interesting? Why?


11. What did you learn from *The Case of the Spurious Spinster*? Would you rate it as a "good" book or as educational? Explain. Was it entertaining? Explain.

**VIRGIL TIBBS**

John Ball, unlike Erle Stanley Gardner, created a fully delineated detective in Virgil Tibbs. Though Tibbs remains a loner, this is through no choice of his own; rather, he is forced into such a position as a victim of prejudice. Ball provides the reader with the thoughts of Tibbs (and other characters as well). We learn of Tibbs' family, of his educational and employment backgrounds, of his disappointments and his concerns. In fact, Tibbs emerges as a flesh and blood character whom the reader gets to know. He is memorable—not for his feats of logic—but for his complex personality.

Perhaps this full-blown characterization enabled the film-maker to create the immensely popular and critically acclaimed film, *In the Heat of the Night*. It is interesting to note that the film was released about twenty years ago, and that Virgil Tibbs has been resurrected once again in yet another "In the Heat of the Night"—the '80s television show. I have decided at this juncture to reverse my earlier decision to use TV as an introduction to character. It seems to me that students should be introduced to the original Virgil Tibbs first. When we have completed our study of the novel, *In the Heat of the Night*, and/or thought about
its rendering of a particular person in a particular place and time, perhaps we will be in a position to appreciate the longevity of the character, Virgil Tibbs.

In the Heat of the Night

In the Heat of the Night is a fast-paced book set in a moribund town. The nightmarish quality of the plot’s twists and turns mirrors the frantic actions and reactions of Wells’ populace who, with few exceptions, pitifully scramble for mere and illusionary vestiges of dignity and respect. Wells is also a hellishly claustrophobic place of meticulously labeled social strata and, paradoxically, no real power base. Off the main highway, both literally and figuratively, Wells is a place we would like to forget. John Ball wisely forces us to take a long, hard look at that which we would rather by-pass. By forcing the reader to reside in Wells for a while, he is able to illustrate the horror and, equally important, the pity of ignorance and prejudice.

Though In the Heat of the Night is told from an omniscient point of view with the thoughts of many characters made available for the reader, its focal point rests squarely on one Sam Woods. That is, it is Woods’ perspective which dominates the novel. Perhaps this is so in part because major characters, Gillespie and Tibbs, are new-comers and outsiders to Wells. To be sure, Gillespie is trying to break into Wells’ society while Tibbs would just as soon turn his back on it, but the fact remains—neither man is a native, and as vulnerable as Tibbs and Gillespie are, neither man is as vulnerable to the thought patterns and the subtle dangers of Wells as is one of its own.

Virgil Tibbs, because he is an outsider and black, is initially arrested as a suspect for murder by Sam Woods. Woods and Gillespie (as prompted by the town council) seek a quick and preferably straight-forward answer to the outrage of murder. A thoughtful and circumspect investigation is not suggested by the town fathers; rather, the opposite is hoped for. It is in the best interest of the town to find a perpetrator to appease the wealthy Mr. Endicott and insure that the murder victim’s plan for a music festival remains intact.

Gillespie, with his own career advancement to think of, eventually arrests two innocents, one Harvey Oberest and his own deputy, Sam Woods, on clearly flimsy and circumstantial evidence. Were it not for Virgil Tibbs, the town fathers would have had their man, and the corruption beneath the false rock of respectability of Wells might never have been unearthed.

Needless to say, Virgil Tibbs meets resistance at virtually every turn. He endures verbal insult and the threat of physical injury with remarkable integrity.
He is a seeker of truth—an intelligent man of self-respect who can afford to respect others. Easy answers of black and white or right and wrong are seen by Tibbs as just that—easy and superficial. According to Tibbs' actions human behavior is complex and not easily relegated to merely the good and evil of things. Thus while Tibbs recognizes the inbred racist responses of Sam Woods, for example, he recognizes as well the essentially good man beneath the damaged veneer. Virgil Tibbs lives by a code of honor and dignity. Even the spectre of blind prejudice is diminished at least for a time in his presence, for Virgil Tibbs does uncover the truth.

We eventually learn that it is the most damaged contingent of Wells which is responsible for the murder. Ralph, the pathetically ignorant and despised counterman, who is vociferously racist as a desperate plea for respect, is as much victim as perpetrator. He is entrapped by an equally pathetic teenager, Delores Purdy, who attempts to use her sexuality to escape her "white trash" roots. (The accidental killing of Mantoli occurs during an attempted robbery [by Ralph] for the procurement of money for an abortion for Purdy.) These are pitiful and sordid acts which underscore all of the weaknesses of Wells' stratified society and/or perhaps illustrate a moribund South of the 1960s. For where does one place the blame for the destructive actions of the pitifully ignorant and bigoted? How is self-respect and respect for others to be instilled in those who are destined for economic (and thus social) disaster?

In the Heat of the Night illustrates all forms of prejudice in myriad examples of characters' stereotyping and various levels of destructive ignorance. Yet, perhaps more forceful is the depiction of those who instinctively recognize and are ashamed of their prejudiced attitudes—those who, like Sam Woods, nevertheless give in to inherited social pressure out of fear of reprisals. One hopes that Sam Woods has grown—or at least has learned that even the most seemingly innocuous form of prejudice may result in self-destruction. But, sadly, by book's end it is not clear that he (or Gillespie) have really understood.

"In the Heat of the Night" television program

Though there are many correlations to be drawn between the television episode in question and the novel, In the Heat of the Night, the television show, unfortunately, presents an easy and superficial response to the problems of racism and violence. The plot is problematic and essentially weak, and, more important, the characters of Tibbs and Gillespie are virtually unrecognizable as John Ball's original characters. While the novel, In the Heat of the Night, is disturbing for the
complex questions it raises, the television version is disturbing for its simplistic rendering of community and character. In a sense the television show trivializes Ball's work with its attempt to portray an economically revitalized and (albeit uneasily) integrated South.

Like the novel, the television show focuses on a home-grown policeman who is unjustly accused of a crime. However, Bubba is a watered-down version of Sam Woods. Like Woods, Bubba occasionally articulates racist attitudes, but these are written off as unfortunate mistakes made in the heat of anger. Virgil Tibbs' initial response to Bubba's expression of racism: "The truth of a man usually comes out when he is angry" is a throw-away line. Tibbs all too easily eats those words in an undignified effort to cement his superficial relationship with Bubba.

Essentially the Howard Rollins characterization of Virgil Tibbs is a travesty of the original Tibbs. He is a reactor rather than a thinker. (The case in question is virtually solved by accident.) More disturbing is his "side-kick" mentality; at every turn he defers to the real man of power, Gillespie. Carol O'Connor's Gillespie is also a travesty of Ball's creation. O'Connor portrays, not a weak man plagued by self-doubt, but a wise-cracking, in-control tyrant who manages all manner of people and problems in his realm with "down-home" humor and beautifully articulated but nonetheless intellectually insulting platitudes. The message of the television program seems to be: the issue of racism (and any other issue one might want to think of) is dead; don't bother to think about it.

The crimes in question have nothing to do with racism. The rape of a white woman and the attempted rape of a black woman are crimes committed by someone barely even recognizable to the viewer. The motive for such crimes remains unknown. (We are to regard the crime of rape as "just one of those things," it seems.) The motive for a cover-up by the white woman is as pathetic as Delores Purdy's motive for blackmail; however, the motive as articulated in the television show is also ridiculously unbelievable: The woman could not reveal her employer-turned-rapist because he (alone in the economically sound Sparta) offered her a bit more than the minimum wage as a store clerk, and she needed the job. Thus it seems that even the socio-economic issues raised by John Ball are to be trivialized in the '80s version of In the Heat of the Night.

To be sure, we must concede that the television show is attempting to depict an '80s rather than a '60s Southern town—or is it? Obviously, Sparta is not Wells. The fly-spattered diner has been replaced by a cute "country-decorated" rendition of a Ho-Jos restaurant. All of the townspeople are attractive—healthy appearing and well-dressed. More important, the stratified society as depicted
in Ball’s book is obviously dead in Sparta. Yet, anyone who had recently read the novel would surely question the notion of the stellar economic revitalization of the South as depicted in the television show.

All of the neighborhoods shown in the show are well-cared for and pretty. Virgil Tibbs, on a detective’s salary, lives in a large and imposing home. (The white woman who was raped appears to be an aberration in this ideal and homogenized town.) In short, one eventually comes to the conclusion that Sparta is not a reflection of an ’80s Southern town—or any town anywhere for that matter. Then the truly important questions emerge: Why are the real Sparta and all the people in it white-washed? What happened to the concept of hero as delineated by Ball’s Tibbs? Why is the mediocre intellect of Gillespie now depicted as firmly in control?

“In the Heat of the Night”—the television show—is most disturbing for its mindlessness and lack of integrity. As a reflection of the concerns and preoccupations of the ’80s it is (one hopes) grossly deficient. As a re-written “history” of the characters of Gillespie and Tibbs, it stands as the worst kind of propaganda or as an Orwellian nightmare come true.

Some Questions for Students:

1. Why does John Ball choose an omniscient point of view to tell his story? Why is the focus on Sam Woods’ thoughts rather than those of Gillespie or Tibbs?
2. What qualities enable Virgil Tibbs to solve the case? Is Tibbs heroic? Explain. In what ways is Gillespie deficient?
3. Why do the town fathers want a quick closure to the murder case?
4. Describe racism as depicted in In the Heat of the Night. Does the author depict a variety of racist attitudes? Explain. Does the author suggest reasons for the existence of racism?
5. Discuss the social structure and the economic conditions of Wells. How are these conditions related to racism?
6. Discuss the motive for murder. Who or what is to blame for the death of Mantoli?
7. Do any of the characters “grow” during the course of the novel?
10. Did you learn anything from reading *In the Heat of the Night*? Was it educational and entertaining?
11. Compare/contrast the criminal motives depicted in the novel and the television show with regard to believability and/or realism.
12. Compare and contrast Bubba and Sam Woods. Is one better delineated than the other? Explain.
13. Contrast Wells and Sparta. How do you account for the apparent differences?
14. Contrast the ways in which the varying characters of Virgil Tibbs (novel and television show) react to attitudes of racism.
15. Is the Howard Rollins' characterization of Virgil Tibbs heroic? Explain.
16. Is the Gillespie character white-washed for the television show? (Why is he so different from the original?)
17. Compare/contrast the (intended and unintended) racist attitudes depicted in the television show and novel.
18. Does the television show present a truthful rendering of time and place? Explain.
19. Which was more disturbing—the television show or the novel?
20. Compare and contrast the show and the novel with respect to educational usefulness and entertainment value.

**SPENSER**

Robert Parker's Spenser is a curious amalgamation of opposite qualities. At once arrogant and self-deprecating, macho and reflective, Spenser combines the life of the body (physical action) with a life of the mind. In fact, his life seems to be dedicated to finding a balance of things both in himself and in the world at large. Though the paradox of Spenser—as seen in his passionate interest in life and his equally apparent self-destructive tendencies—remind one of the complex character of Sherlock Holmes and other detectives, for that matter, Spenser is essentially new. He is not the cold, scientific cynic portrayed by Holmes, nor is he the lone, reactive idealist portrayed by Travis McGee.

Spenser is a philosopher who has found no answers for living life; rather, he is one who continually seeks new questions. He is at once a mundane man and a super man—one is never sure which. Perhaps this, too, is the point. With the creation of Spenser and, equally important, with the inclusion of myriad illustrations of a society of shifting ethical stances, Parker reminds us that it is the
questioning that is important—not the answering. (Put another way, it seems that there are no firm answers anymore; each will have to find his or her own way.)

“Spenser: for Hire” television show

Though all of the nuances of character of Spenser as mentioned above cannot be articulated in a television show of an hour’s length, “Spenser: for Hire” does reflect Robert Parker’s questioning stance. To be sure, Robert Urich in the role of Spenser has little time to question his own motives in the episode, “My Brother’s Keeper.” Yet, questions about the Vietnam War, and the larger question of the ethics of killing, are at least posed. Though the television show presents a superficial rendering of character, it illustrates a society doing battle with ethical dilemmas. Unlike “In the Heat of the Night”—the television show—“Spenser: for Hire” has some integrity and/or presupposes that its audience might be interested in issues of truth.

We learn early on that Spenser (and Hawk) are veterans of the Vietnam War. Spenser initially gets involved with the case in question because of his own ambivalent feelings about war; specifically, he wonders whether or not to reopen and/or reflect upon the experience by renewing war-time friendships.

Interestingly enough, when the opportunity arises for reuniting a veteran-turned-Vietnam War author and the Vietnamese man he once saved, Spenser (admitting vicarious involvement) enthusiastically arranges the meeting. Unfortunately, as it turns out, Spenser has been unwittingly used by a Vietnamese thug. (This naturalized U.S. citizen wishes to suppress the book on Vietnam, for it exposes his own dirty DEALINGS both in Vietnam and in the United States.) Ultimately Spenser’s arranged meeting leads to the death of the Vietnam War author. Spenser arrives too late (on separate occasions) to prevent both the shooting of the author and the theft of the manuscript.

Two interesting sub-plots emerge during the course of the television show. First, it seems that the author in question killed one of his own men in combat as an act of mercy, and thus faces certain reprisals should either he or the Vietnamese eye-witness to the act reveal the truth. Second, we learn that the author has remained estranged from a brother who chose to flee to Canada rather than engage in the fighting in Vietnam. The connection between these sub-plots becomes apparent when the pacifist resolve of the conscious objector is shaken by an encounter with his brother’s killer.
At this moment the ethical stances of both brothers are called into question, and one is prompted to ask many questions including: Is the answer of the pacifist—"One should never kill under any circumstances"—too easy? Are there people who need killing as Hawk states? Would war-time killing be equated with murder? Which brother displayed true courage? How much control do we essentially have over our ethical stances? Is mercy-killing ever acceptable? When mercy-killing is condoned, is a law disregarded? What are the dangers of bending a law? Do citizens ever know the truth of a war? These are only some of the questions the television show raises.

Though we eventually learn that the author finally accepted the stance of his pacifist brother, the right and the wrong of things is never answered. Rather, the program implies that ultimately each has to find his own way. And even this "answer" raises questions, for what are the repercussions of the acceptance of individualism and paradox as stated by Spenser near the show's conclusion: "This shaking keeps me steady . . . I learn by going where I have to go"?

Mortal Stakes

*Mortal Stakes* finds Spenser hired to discover whether or not a baseball hero, Marty Rabb, is throwing games. Spenser eventually learns: 1) that the pitcher is being blackmailed because of his wife's dubious past 2) that Rabb is giving in to coercion despite serious misgivings and/or the realization that in so doing he is breaking his own code of honor. *Mortal Stakes*, like many of Parker's books, is about honor and the ethical code of the individual. Its primary focus, however, is the notion of game-playing.

The game of baseball provides an obvious symbol of modern reality and the American (male) experience. The patterns of behavior as articulated in *Mortal Stakes* include experiences of endurance and, equally important, experiences of competition. More important, the metaphor of the game enables Parker to describe the elemental struggle for power and dominance (amidst tried and tested rules and strategies.) One is constantly reminded of the dual nature of man in *Mortal Stakes*—of animal needs and civilized desires.

Spenser's "game" has to do with stemming the tide of the most uncivilized, and he heartily plays the adult version of "cops and robbers." Like Sherlock Holmes, Spenser is called to action when the "game is afoot." Unlike Sherlock Holmes, he occasionally question his actions. For example, Spenser is easily felled by Linda Rabb's accusation that he is childish or an adolescent. This leads him to question both his own desire for dominance and his acceptance of an imperfect society's rules. However, a bit later in the story, he consoles himself
with bourbon and the belief that the game in question is for mortal stakes—for the protection of family and of love.

It is Spenser's dual nature—his macho as well as his reflective sides—that reminds us that in addition to themes of competition and dominance, Mortal Stakes also has to do with the idea of "going home" (as the late A. Bartlett Giamatti, Commissioner of Baseball and former President of Yale University, would describe baseball); Mortal Stakes illustrates man's need for (and thus fierce protection of) nurture and love. Spenser's relationship with Susan underscores his reverence for "home." This acceptance of "home" as somehow transcendental prompts him to protect Linda and Marty Rabb at all costs. It is the balancing act that men are destined to perform (as nurturers and aggressors) which seems to interest Parker. Put another way, Spenser's experience illustrates the paradox of morality and/or mirrors the human condition.

Perhaps the most interesting and crucial scenes in Mortal Stakes are those where Spenser, in reaction to the most contaminating influences of society, reverts to animal tactics of aggression and brutality. On one occasion he loses all control of himself and nearly beats to death a character who is (ironically) the very symbol of machismo. Though the victim is the essence of corruption, and thus invites Spenser's wrath, one wonders whether Spenser is seeking to destroy as well that which reminds him of an integral part of himself. The beating follows Spenser's coolly calculated elimination of those who sought to destroy the Rabbs; though Spenser was induced to commit these killings for self-preservation's sake, he is clearly distressed by the acts—or by the necessary breaking of his code (never to kill people voluntarily).

Mortal Stakes illustrates the many dangers of "playing the game." One may be contaminated by the very rule-breakers one seeks to dominate. One's ethical stances continue to shift. Yet, not to play the game—not to question, not to seek balance—is to be already dead. The game is, after all, for mortal stakes.

Some Questions for Students:

1. What personal reason prompts Spenser to arrange the meeting between the author and his Vietnamese friend in "My Brother's Keeper"?
2. Why is the author's brother included in the plot of the television show?
3. What questions does the show raise about the ethics of killing? (war-time, mercy, etc.)
4. Was the television show entertaining and educational?
5. Give examples of the dual nature of Spenser as articulated in the novel (macho/reflective, nurturer/aggressor).
6. *Mortal Stakes* revolves around the game of baseball. In what ways is the detective, too, playing a game? (Think of qualities of endurance, competition, desire to dominate.)

7. What prompts Spenser to question his own actions?

8. What is Spenser willing to risk in protecting what the Rabbs have? Why?

9. In what ways does the novel reflect the human condition? (How does Spenser’s experience reflect the dilemmas facing modern man?)

**ADDITIONAL LESSON PLANS**

1. **Film: *In the Heat of the Night***
   
   A. View in class (taking notes on the use of film elements; see 1988 unit, “America in Film and Fiction,” for discussion/definitions of film elements. Hand-out available for students.)

   B. Sample questions: film elements
      
      1. Comment on the opening music. Is it appropriate? Explain. (background music)
      
      2. Why is Tibbs’ face not shown as he leaves the train? Why do his legs/feet fill the frame? (composition)
      
      3. Comment on the use of blue light as associated with Tibbs and orange light as associated with Gillespie. How is the use of lighting echoed in characters’ clothing? (lighting)
      
      4. Contrast Tibbs and Gillespie with regard to ways of speaking, posture, and movement. (dialogue/subject movement)
      
      5. Temperature (heat) is symbolic in this film. Explain. How is the feeling of heat projected in this film? (film stock)
      
      6. Comment on the use of high angle and low angle shots during the scene where Gillespie discovers that Tibbs is a police officer. (points of view)
      
      7. Discuss the use of shadows in interior settings (police station, cell). Who casts shadows (Tibbs or Gillespie)? Discuss the use of the cross motif (shadow on wall of cell). (lighting)
      
      8. A wide angle shot is used when Tibbs is leaving the Endicott home. How does this serve to enhance the character of Tibbs? (subject movement) Discuss the use of the pan shot in depicting the Endicott home. (camera movement)
      
      9. Discuss the use of synchronous and asynchronous sound during the scene where Tibbs is threatened by the town’s hoodlums.
10. Why is Delores Purdy often depicted within a tilted frame? composition?

C. Questions: film adaptation of the novel
   1. Are Poitier/Steiger's renditions of character true to Ball's creation? Explain.
   2. Is the setting as portrayed in the film recognizable as the original setting? (Discuss the film's renditions of setting and character.)
   3. Why were the following changes made in the film version?
      a. Endicott (in the film version) is a racist and the number one suspect of Tibbs.
      b. Tibbs is confronted by physical danger many more times in the film version.
      c. The character of the abortionist is included in the film. (What is gained and lost with such changes?)

D. Film/television episode: Other than additional time (which enables better character delineation) what does film offer that television does not? Why? Could TV be doing more?

II. Outside Reading
   A. Choose either a Parker novel or a Gardner novel for outside reading.
   B. Follow-up assignment: report to be presented in class based on the following questions:
      1. Why did you choose the Gardner or Parker novel?
      2. Briefly summarize the plot of the novel: crime committed, motive for crime, denouement as handled by detective
      3. Discuss particular issues which are raised during the course of the novel which seem to reflect its particular setting. Possibilities: family issues, drugs/alcoholism, political/government issues, racism, women's issues, environmental issues, issues of morality. How are these issues made clear? What is the author's stance regarding these issues? Are the issues viable today?

Student Reading List


Teacher Reading List


Film

Jewison, Norman, director. *In the Heat of the Night*. United Artists, 1967. (available on commercial videocassette)
From *Plessy v. Ferguson* to *Brown v. Board of Education*: The Supreme Court Rules on School Desegregation

Karen Wolff

Stories of racial tension and racial violence abound in the news. The controversy over forced desegregation and busing is again getting top billing in the newspapers. Should the United States government legislate desegregation? Is racial mixing desirable and/or necessary in our educational system? As a teacher I feel that these issues must be brought into the classroom in such a way that students can understand the different positions and can figure out their opinions. For adolescents, learning to work with and relate to people of all different backgrounds are important skills. For urban children, racial questions are of immediate concern. Schools are a major focal point for them. For this reason, I have chosen to study the history of school desegregation legislation with my students.

This unit has been organized for students with a high school reading level. Since 1982, when I prepared it, it has been used as a segment of a course at the High School in the Community, an inner city magnet high school which is teacher run and very supportive to teacher initiated curriculum. I first used the unit as the history half of an interdisciplinary course in English and history. The English component focused on forming opinions and writing essays. The class meet daily for three hours. I have since used this unit in conjunction with other subjects such as statistics and poll making, drama in the courtroom, and philosophy as reflected in various legal systems throughout history. Since this course has proven to be very stimulating for the students, I have also expanded it into a larger course on the American Legal System.

Although I have planned this course for a particular context, I feel that both the material content and the format can be applied in many other school set-
tings. This course has stimulated student interest in history, current events and the power of the American legal system. Using primary sources such as legal documents, newspaper and magazine articles, and autobiographical essays, students are exposed to many different points of view. They learn that history is alive and powerful in their world. The legal system works with decisions made in the past, applies them to the present and then reshapes the future. The students in these classes have found that they really enjoyed studying and debating the legal issues that I have raised as they pertain to many different aspects of American life today.

INTRODUCTION: THE SIGNIFICANCE OF BROWN V. THE BOARD OF EDUCATION, TOPEKA, KANSAS

The Supreme Court decision in Brown v. The Board of Education of Topeka, Kansas has been credited with much significance. For some, it signaled the start of the civil rights movement of the 1950s and 1960s, while for others, it represented the fall of segregation. Even in the footnotes of the decision, however, the Court raised questions as to how much authority it had and how to proceed toward getting compliance. In the brief summary of events that follows, I have drawn primarily from Kluger's study, Simple Justice.

The Brown decision was a landmark because it overturned the legal policies established by the Plessy v. Ferguson decision that legalized the practices of “separate but equal”. In the Plessy decision, the 14th Amendment was interpreted in such a way that equality in the law could be met through segregated facilities. Jim Crow laws were passed throughout the South and they established separate facilities for Blacks and Whites in everything from schools to restrooms, drinking fountains to witness stands in courtrooms.

For many years, the Civil Rights movement during the first 50 years of the 20th Century accepted this policy of “separate but equal” in its struggle for access into the society. It fought in many communities for equal pay for teachers and for equal school facilities. It fought for equal libraries, recreational facilities, and health services. Plessy defined the terms of the struggle.

The Brown decision came about after a series of Supreme Court decisions on specific educational challenges. The first was that universities must admit Blacks to graduate facilities if a desired course of study was not available in a Black institution. Then in Sipuel v. Board of Regents of the University of Oklahoma, in 1948, the Court ruled that Blacks must be admitted to state universities because they offered many opportunities not available in Black institutions. In 1950 in
Sweatt v. Painter, the Court ruled that a separate Black law school, established for Sweatt after he sued for admission to the University of Texas Law School, was unequal not only in physical facilities and curriculum but in reputation and opportunity for stimulating professional contact. In Laurin v. Oklahoma State Regents, also in 1950, the Court ruled that the state violated the “separate but equal” doctrine when it required isolated cafeteria and classroom seating for Black students because it produced unequal educational opportunity.

The Brown decision established that separate schools were ipso facto unequal. It allowed proponents for better opportunities for Blacks to fight for positive gains and full equality. But the fact that there were few means to implement these decisions became clear as it became obvious that few gains were being seen by 1960, the year that a new student Civil Rights movement was founded.

Immediately after the Brown decision, many attempts were made to begin desegregation. NAACP chapters encouraged Black parents to send their children to “White” schools, and there had been retaliation against those who did. There had also been three mass marches on Washington on the school issue. On May 18, 1957, the anniversary of the Brown decision, about 35,000 attended a prayer pilgrimage for integrated schools sponsored by both northern and southern civil rights leaders, a first joint effort. In 1959, 400,000 signatures were presented to Congressman Charles Diggs petitioning the President and Congress for a program to insure the orderly and speedy integration of schools.

The legal struggle for integrated schools dragged on in the years following the Brown decision. Southern school boards and state governments brought suit after suit challenging it and then created a variety of ways to get around the intent of the decision. In those few localities where there was at least minimum compliance, intimidation and violence were used to keep the White schools White.

Nevertheless, the Brown decision did provide a setting for major confrontations between the federal government and the states, and between the Black and White populations of several Southern cities. Anthony Lewis, a reporter for The New York Times, in a study of school desegregation, pointed out that there were rapid steps taken toward desegregation in Kansas, Arizona, Washington, D.C. and Baltimore. In 1954, 1955, and 1956 hundreds of school districts began to abandon racially segregated school classes. But then reaction seemed to set in and most Southern political leaders began to take defensive positions.

There were many examples of this reaction. In Clinton, Tennessee, the school board and other White citizens faced down a mob in 1956. The high school was bombed in 1958. In 1956 the presence of Atherine Lucy set off
rioting at the University of Alabama so the University officials asked her to withdraw. The federal government did not respond to the University's request for aid. In 1962, James Meredith entered the University of Mississippi despite serious rioting. In this case President Kennedy had sent in federal troops. This event was publicized throughout the world. Another shocking reaction was that of Prince Edward County. There, the public schools were closed down for 5 years, from 1959 to 1964. This county in Virginia closed their schools rather than desegregating them. The schools were not reopened until the Supreme Court ruled that they had to be reopened. 1700 Black school children had no schooling from 1959 until 1963 when a Free School was opened. It remained open until June, 1964, when the county was forced to operate public schools again.

Little Rock, Arkansas, was the site of a confrontation of major significance to the future of changing racial attitudes. The whole world read about the 15 year old Black child who was turned away from the Little Rock Central High School by the National Guardsmen into a mob of screaming White people. They were screaming, “Lynch her, lynch her!”

This short history raises some important questions for Americans still today. Our schools are still by and large not integrated—and probably not even desegregated. All over America people are calling for “quality” education and “neighborhood schools” rather than for forced integration. Today few people say that “separate but equal” is legally acceptable but de facto segregation has again become a reality.

OBJECTIVES

I have five objectives for this unit.

The first objective is to show students that racial issues can be discussed openly. By giving them exposure to an historical approach to the crucial aspect of American life, I want them to learn to articulate their ideas and share them in class.

The second objective is to show students how decisions made by the Supreme Court on the constitutionality of lower court decisions can directly influence people's lives.

The third objective is to teach students that historical times shape people’s ideas and behavior.

The fourth objective is to teach students how to use primary sources for understanding history.
The fifth objective is to expose students to the methods used to shape legal thinking and argumentation.

STRATEGIES

Primary sources will be used extensively in this class.

Understanding them and interpreting their meaning in different historical contexts will help students see how history shapes thinking and influences people's lives. Each week one primary source will be read, summarized and discussed in class. Background information will be added through readings from a text book, These United States, and from lectures in class. Each Friday there will be a quiz given and students will be asked to interpret the significance of the primary source. During the final week, the students will be asked to take a position on a topic which had been discussed in class and present their argument to the class orally and in essay form. Here is an outline of the weeks:

Week 1: The 14th Amendment
Week 2: Plessy v. Ferguson and Justice Harlan's Dissent
Week 3: Living with Jim Crow: Richard Wright Remembers
Week 4: Brown v. Board of Education of Topeka, Kansas
Week 5: Working for Desegregated Schools: Daisy Bates and Robert Coles
Week 6: Busing and Forced Desegregation: I Believe

WEEK 1: THE 14TH AMENDMENT

This week's work will focus around reading and understanding the 14th Amendment to the Constitution of the United States. In this amendment, all citizens of the United States, either by birth or naturalization, are assured equal protection of the law. No person can hold office if they have engaged in a rebellion against the federal government. The government is not responsible for debts accrued by state governments during a rebellion—this includes the costs involved in the loss of emancipated slaves. It is also clearly stated that the Congress shall have the power to enforce this amendment by appropriate legislation.

We will also look into the distinctions made between the three post-Civil War Amendments. While the 13th abolished slavery and the 15th established the right to suffrage, it was the 14th which was to guarantee civil rights. The stipulations of section 1 of the 14th Amendment left much of the jurisdictional issues vague as to
the limits of federal and state laws. (So for example, it was not until the Civil Rights Act of 1964 that housing was brought under the jurisdiction of this amendment.)

This amendment consolidated the power of the radical Republicans in the South. By protecting the rights of Black Americans they hoped to keep them loyal to the Republican Party and the newly formed federal government. However, the amendment has been interpreted in contradictory ways—to legislate both segregation and integration. By granting Blacks and Whites equality in the eyes of the law, the 14th Amendment undermined the Black Codes in the South passed during reconstruction and reasserted the right of the federal government to intercede if states blocked their rights.

The signing of the 14th Amendment became a requirement for reentry into the Union after the Civil War. It consolidated the power of the Northern states and the Republicans. But their power was soon undermined as the southern states started passing new segregation laws and the advent of Jim Crow policies again denied Blacks equal rights and opportunities.

Students will also be assigned readings in the school American History textbook for background information on this.

**Week 1: Assignments (in class / homework)**

*Tuesday:* Discuss readings, review definitions / Read Constitution and 14th amendment
*Wednesday:* Discuss Constitution and Supreme Court / Write summary of 14th Amendment
*Thursday:* Read summaries / Review week
*Friday:* Quiz and in-class essay

**Major Discussion Topics:**

1. Why were most slaves in the South?
2. Why did the South secede?
3. How are the powers of the state and Federal governments determined?
4. What powers does the Supreme Court have?
5. How can the Supreme Court enforce its decisions?
6. What does the 14th Amendment really say?
WEEK 2: PLESSY V. FERGUSON AND JUSTICE HARLAN'S DISSENT

This week we concentrate on the Plessy v. Ferguson case and Justice Harlan's dissent. These documents may be found Gerald Gunther's book, Cases and Materials on Constitutional Law. In this decision the Supreme Court decided that "separate but equal" accommodations for Whites and Colored railroad passengers did not violate the rights established in the 14th Amendment. Justice Brown gave the majority decision and he explained that although the Amendment was "undoubtedly to enforce the absolute equality of the two races before the law, it could not legislate the abolition of all distinctions. Laws requiring the separation of the races simply reflected the culture of the people and as long as facilities were equal they were not prejudicial". Separation need not imply inferiority of either race. Brown did not feel that social prejudice could be overcome by legislation: "If the two races are to meet upon terms of social equality, it must be the result of natural affinities, a mutual appreciation of each other's merits, and a voluntary consent of individuals."

On July 19, 1890, the Louisiana General Assembly passed an act that provided equal but separate accommodations for each race for the comfort of all the passengers. The law was denounced by the American Citizen's Equal Rights Association of Louisiana Against Class Legislation. This group of well-to-do Blacks raised money and challenged the constitutionality of the law. But it was not until Adolph Plessy entered a train and sat in a "For Whites" car that a test case was brought to the Supreme Court. The presiding Judge, Judge Ferguson, of the Criminal District Court of New Orleans found the law constitutional as did the Louisiana Supreme Court. The case was heard in the Supreme Court in 1896. During this period many new Jim Crow laws had been passed throughout the South. Alabama, Arkansas, Georgia, and Tennessee passed laws requiring railroads to separate the races. Mississippi and South Carolina already denied the vote to Blacks and many other states were preparing to take the same steps.

There were real differences of opinion within the Black community over these rulings. On one side were those Blacks who felt that they must adjust to the growing sentiment against their civil rights by developing the economic standing of Blacks before working for equal rights. So Booker T. Washington delivered a speech at the Atlanta Exposition in 1895 stating: "In all things that are purely social, we can be as separate as the fingers, yet one as the hand in all things essential to mutual progress. The opportunity to earn a dollar in a factory just now is worth infinitely more than the opportunity to spend a dollar in an opera house." He urged Blacks to become experts in var-
ious economic positions so that the Black man could win a place in the White man's world.

On the other hand, W.E.B. DuBois argued for full, legal equality immediately. He felt that Washington's position relocated Blacks to half manhood—a worker with no civil rights. Thus he led the Niagra Movement which declared, "We want full manhood suffrage and we want it now." This organization grew into the National Association for the Advancement of Colored Peoples (NAACP), the organization which led the struggle against segregated schools and for civil rights for Blacks.

Seven Justices ruled against Plessy, but one, Justice Harlan, dissented. He asserted that justice should be color blind and that the enforcement of "separate but equal" interferes with the personal freedoms of individuals by legally forcing separation. As he stated, "Sixty million whites are in no danger from the presence of eight millions of Blacks . . . The destinies of the two races in this country are indissolubly linked together, and the interest of both require that the common government of all shall not permit the seeds of race hate to be planted under the sanction of law." He foresaw that the decision would lead to a pattern of behavior which would be very dangerous and undermine a basic sense of justice.

Week 2: Assignments (in class / homework)

_Monday:_ Review Friday's quiz / Read _Plessy_ and Harlan's Dissent  
_Tuesday:_ Discuss decision and dissent / Write summary of each document  
_Wednesday:_ Read summaries in class / Rewrite and correct  
_Thursday:_ See movie on life in segregated South / Write reaction to movie  
_Friday:_ Quiz

Major Discussion Topics:

1. What were the arguments for "separate but equal" legislation?
2. What were the arguments against this legislation?
3. Does separate but equal imply inferiority?
4. How can equal facilities be determined?
5. What is a dissent?
6. What are the implications of Harlan's dissent? Should the government tell people how to live or make rules that reflect how they live?
WEEK 3: LIVING WITH JIM CROW

The two readings for this week are about Jim Crow legislation and how it felt to live within these restrictions. In the excerpt from The Strange Case of Jim Crow, C. Vann Woodward discusses the expansion of “separate but equal” legislation throughout the South. After quoting a Southern critic of the policy who pointed out the absurdity of the legislation, he reviews the major restrictions passed in this period. These laws restricted travel, housing, use of private and public facilities, amusement parks and other recreational areas, and of course schools and institutions of higher learning.

The second reading is an excerpt from Richard Wright’s Uncle Tom's Children. In “The Ethics of Living Jim Crow”, Wright describes how he learned to live with the double standards implied by “separate but equal.” Out of fear for her son’s life, Richard’s mother beats him for standing up to White children. He learned the same lesson when he tried to assert his rights on his job—he wanted to learn information which certain White workers felt was not his place to learn. This autobiographical sketch is an excellent introduction to the consequences of Jim Crow legislation and attitudes.

Week 3: Assignments
(in class / homework)

Monday: Review quiz / Read Woodward
Tuesday: Discuss reading / Answer questions on Woodward
Wednesday: Review homework / Read Wright
Thursday: Discuss reading / Answer questions
Friday: Quiz

Major Discussion Topics:

1. What was the purpose of the Jim Crow laws?
2. Why were they predominantly in the South?
3. Did these laws affect Blacks and Whites in the same ways?
4. What does it “mean” to be a member of a minority group?
5. Why would a person write an autobiography? Why would someone want to share such pain?
WEEK 4: BROWN V. THE BOARD OF EDUCATION OF TOPEKA, KANSAS

During this week we will study the Brown decision of 1954 and the reaction of a group of dissenting Southern congressmen. In this decision the Supreme Court concluded that in the field of education, the doctrine of “separate but equal” was unacceptable. Segregation is a denial of equal protection of the laws as defined in the 14th Amendment.

After hearing a series of cases brought on behalf of Black students in segregated schools, the Court reviewed the circumstances surrounding the adoption of the 14th Amendment. This research proved inconclusive because it was clear that each side of the ratification debate had different goals. The proponents wanted to eliminate all legal distinctions while opponents wanted to limit the applicability of the Amendments.

They found, however, that after reviewing the history of public education since the ratification of the Amendment, they had a basis upon which to declare “separate but equal” legislation unconstitutional. Education is one of the most important functions of government. Compulsory education and public expenditures for education demonstrate this importance. The right to a good, equal education was fundamental to our democratic society. They thus asked the question, “Does segregation of children in public schools solely on the basis of race, even though the physical facilities and other 'tangible' factors may be equal, deprive the children of the minority group of equal educational opportunities?” Their answer was clear and unequivocal—"We believe it does." Separate educational facilities are inherently unequal.

This decision came at the culmination of a series of court cases challenging segregated schools. Initially, the NAACP fought against segregated graduate school facilities. In this case, however, the plaintiffs were Black children of elementary school age residing in Topeka, Kansas. This action was brought to the United States District Court for the District of Kansas to enjoin the enforcement of a Kansas statute which permits but does not require cities of more than 15,000 population to maintain separate school facilities for Black and White students. Based on that authority, the Board of Education of Topeka elected to establish segregated elementary schools. Other public schools were run on a nonsegregated basis. The three judge District Court found that segregated public schools had a detrimental effect upon Black children, but denied relief because they found that the schools were essentially equal with respect to buildings, curriculum, transportation, and the educational qualifications of teachers.
Other related District Court decisions were Briggs v. Elliott in South Carolina, Davis v. County School Board in Virginia, and in Delaware, Gebhart v. Belton. In Briggs v. Elliott and the Davis v. County School Board, the Courts ordered that the schools be equalized, having established that the facilities and curriculum were unequal. In Delaware, however, after recognizing that the Black schools were inferior with respect to teacher training, pupil-teacher ratio, extra-curricular activities, physical plant, and time and distance of travel, the Court ordered immediate admission of Black plaintiffs into previously all White schools. It should be noted that although the Chancellor of the Delaware Court maintained that segregation itself resulted in an inferior education for Black children, he did not base his decision on this finding.

A group of Southern politicians declared their feelings about the Brown v. Board of Education decision in the Southern Manifesto, the second reading for this week. Essentially they declared that it represents a clear abuse of judicial power. They felt that the federal judiciary was encroaching on the rights of the people. Education has not been mentioned in the Constitution nor in the 14th Amendment or any other amendment. They felt that this action would destroy the amicable relationship between the White and Black races that had been created over the last century. Forcing the races to change their relationship could only produce misunderstanding and hostility.

Week 4: Assignments (in class / homework)

Monday: Review Friday’s quiz / Read text: These United States, pp. 624-643
Tuesday: Introduction to the 1950s / Read Brown and answer questions
Wednesday: Discuss Brown / Read Southern Manifesto
Thursday: Discuss Southern Manifesto / Study for quiz
Friday: Quiz

Major Discussion Topics:

1. What does “inherent” mean?
2. Why would segregated schools be inherently unequal?
3. What is equality in education?
4. Can laws create equality?
5. Can people be forced to mix?
6. Why would Southern Congressmen feel more hostility to the Brown decision than Northerners?
WEEK 5: WORKING FOR DESEGREGATED SCHOOLS

As stated in the introduction, the Brown decision has been seen by some as a turning point. In any case, the decision produced some earthshaking events in the United States. The struggle for desegregated schools and then general civil rights turned out to be a painful one, both physically and mentally. During this week two short excerpts about the early attempts at desegregation will be read.

The first is a brief description of the events leading up to the school desegregation in Little Rock, Arkansas written by Daisy Bates, the president of the state NAACP. In this section of her book, *Thee Long Shadow of Little Rock*, she describes how it came to pass that one Black school child was refused entrance to the high school because of the presence of National Guardsmen.

It first appeared that Little Rock would join many other moderate cities in the south and desegregate their schools with relatively little difficulty. Nine Black students were chosen to attend the formerly all White high school in September, 1957. However, Governor Faubus called out the National Guard to prevent the children from attending the school. This caused a clash between state and federal powers. In reaction to Faubus’ acts, President Eisenhower had to call federal troops to force desegregation. Black students attended the high school under guard for the year 1957-1958. The following year the schools were closed. The next year, however, the schools were opened on a desegregated basis. The whole world watched these events on television.

In the second reading students will learn how a psychiatrist recorded the effects of forced desegregation on the children who fought the struggle. Robert Coles studied these children in his book, *Farewell to the South*. Both Black and White children and their parents were affected by these changes. Children seemed to adjust easily and quickly to each other if left to explore together. They did not, however, remain unaffected by the crowds of yelling adults and the presence of soldiers. In Coles’ essay, “In the South These Children Prophecy”, he reviews the experiences of a few children and gives a real personal touch by adding his feelings and observations.

Week 5: Assignments (in class / homework)

*Monday*: Review Friday’s quiz / Read Bates
*Tuesday*: Discuss reading / Answer questions
*Wednesday*: Share answers / Read Coles
*Thursday*: Discuss reading / Answer questions
*Friday*: Review answers; quiz
Major Discussion Topics:

1. Why would people send their children into these situations?
2. How did sympathetic Whites react?
3. Is prejudice the same as recognizing differences among people?
4. How can one find oneself if one is forced to act a certain way?
5. Can people change? How?

WEEK 6: BUSING AND FORCED DESEGREGATION: I BELIEVE

In this, the final week, we will work on shaping the students' opinions. Before working on position papers, the class will be asked to read a recent article from The New York Times, “Rulings on School Integration Key Target for Conservatives”. Today, almost twenty years after the Bown decision, many of the same issues are still being debated and legislated. In this article, the reporter discusses the recent take-over by conservatives of control of the executive branch and the Senate and their growing influence in the House of Representatives. They are attacking the Federal Courts for intruding into the basic fabric of American life by making decisions which these conservatives claim are beyond their jurisdiction. The management of school desegregation through busing is their favorite target. Charlotte-Mecklenburg, North Carolina, was the first school system ordered desegregated by the use of busing. It is cited as a successful example. Boston, Mass. is presented as a city whose designs for school desegregation by busing have only produced a more tense and segregated school system. At least part of the cause has to do with “white flight”, an issue viewed from many different perspectives. Some feel that busing causes more problems than it solves. This article raises many of the issues raised throughout the course—and brings the debate up to date.

It should be noted that updating should be a continuous process for this course. So, for example, I found an excellent article that brought up the same debates but now in 1991. In January, 1991, the Supreme Court once again limited its jurisdiction in school desegregation cases. This was reported on the front page of The New York Times on January 16, 1991.

During this week students will be asked to choose a topic relevant to the issues discussed in this course and to present both oral and written position papers. I will distribute a list of topics and a form which will help the students organize their thoughts and show them how to complete the assignment. The list of topics will be drawn from in class discussions and readings.
**Week 6: Assignments (in class / homework)**

*Monday:* Review Friday’s quiz, discuss class presentations / Read NYT article, distribute topics and forms

*Tuesday:* Discuss article, discuss presentations / Prepare outline for presentation

*Wednesday:* Review outlines, start presentations / Write up position paper

*Thursday:* Presentations

*Friday:* Presentations, summary of class

**Major Discussion Topics:**

1. What do the words “conservative” and “liberal” mean?
2. Is busing a solution to segregation in schools?
3. What factors maintain segregated schools?
4. Should school desegregation be a major concern in this country when the economy is so weak?
5. Is school integration really important to all of us?

**Classroom Materials**


**SAMPLE LESSON PLANS**

**Week 2: Writing a summary: *Plessy v. Ferguson* and Justice Harlan’s Dissent**

Answer these questions carefully and with full sentences. Then write a brief summary of the two documents.

I. *Plessy v. Ferguson*

What does the 13th Amendment state?
According to Justice Brown and the majority opinion:
- separation does not imply inferiority (explain in your own words),
- separation is generally within the competency of the state legislatures in the exercise of power (explain in your own words). Give three examples listed in which state legislation has sustained separation.

Define reasonable malice power as it is stated in the decision.
What is the underlying fallacy of the plaintiff’s argument?
Define inferiority.
Define natural affinities.
Define voluntary consent.

Explain this statement: “(Legislation) is powerless to eradicate racial instincts or to abolish distinctions based upon physical differences, and the attempt to do so can only result in accentuating the difficulties of the present situation.”

When was this decision made and what was Mr. Plessy complaining about?
Write a brief summary.

II. Justice Harlan’s Dissent

Who is Justice Harlan?
What is a dissent?
What is Harlan’s fundamental objection to the decision?
What is Harlan’s view of legal distinctions based on racial considerations?
What does he feel will be the consequences of this decision?
Write a brief summary.

**Week 2: Form for note taking in class**

*Separate but equal:*

*Jim Crow legislation:*
- Rapid change of status for Blacks in the South after the Civil War.
- Antebellum South
- Reconstruction
- Carpetbaggers
- Plantations
- Industrialization
- Urbanization

Mr. Plessy takes a train ride.
- Judge Ferguson’s decision on Louisiana
- Blacks divided over growth of Jim Crow policies.
- Booker T. Washington
- W.E.B. DuBois

Dissent as a concept.
Justice Harlan’s Dissent seems to foresee the problems with the “separate but equal” doctrine.

**Consider these questions so we can discuss them in class:**

- Does separate but equal necessarily imply inferiority?
- How can equal facilities be determined?
- Should the government make rules that tell people how to live or make rules that reflect how they do live?

**Week 6: My position paper—Outline form**

*Title:*

*I believe:* (State clearly and precisely your opinion about the issue.)

*Reason 1:* (You can give as many reasons as you would like to support your thoughts but there must be at least three.)
Conclusion:

This is to be presented orally in class and written in paragraph form to be handed in to the teacher.

Annotated Teacher Bibliography


**Annotated Film Bibliography**

*Eyes on the Prize*, Vols. 1 and 2. Boston, Mass.: Blackslide, Inc. 1986. These two volumes trace the early history of the civil rights movement in the nineteen fifties. The footage is authentic. The commentary is well presented and easy to follow. The whole set consists of six volumes that go up through the late sixties.

**Annotated Student Bibliography**


The world is to be carried forward by truth, which at first offends, which wins its way by degrees, which the many hate and would rejoice to crush.

—William Ellery Channing, 1849

When we consider what religion is for mankind, and what science is, it is no exaggeration to say that the future course of history depends upon the decision of this generation as to the relations between them.

—Alfred North Whitehead, 1930

INTRODUCTION

Teachers in the New Haven high schools have used this unit in the Law Course offered to seniors, and to juniors taking United States History. I am aware of at least one ninth-grade teacher who has excerpted parts of this unit for use in teaching principles of the U.S. Constitution. Apparently, the materials contained here are readily adaptable for a variety of interest and ability levels.

This teaching unit explores an issue which should be of great interest to both students and professional educators: intellectual freedom. What are the legal boundaries of what may and what may not be taught in public schools? What is the constitutional nature of this question? Besides educators, there are many individuals and groups which have input into the schools: students, parents, and local and state Boards of Education.

Who ultimately has the right to determine what is and what is not permitted to be taught? How often have courts (particularly the Supreme Court) ruled in
cases involving teachers' right to teach and students' right to know? The United States claims to be a pluralistic society in which the rights of minorities are protected. Under law, how does a school system act to indeed protect the rights of minorities within a framework of intellectual freedom and the "right to know"? One of the underlying purposes of this unit is to examine ways of effecting possible changes in schools within the boundaries of the U.S. Constitution.

First, students will examine the issues underlying the famous case that involved a Tennessee science teacher named John Scopes who violated a state law in 1925 that forbid the teaching of Darwin's theory of evolution. The issues of this famous trial will provide the main part of my teaching unit. In this case, famous expert lawyers (in this case the defense had Clarence Darrow plus two other civil rights attorneys who were paid for by the American Civil Liberties Union in New York), came to the defense of a "notorious" defendant. The drama of this case was heightened by the presence of three-time Presidential candidate and religious leader, William Jennings Bryan, who took the witness stand in a defense of Bible truth and in opposition to evolutionary teaching. The famous "monkey trial" is history, with Scopes' penalty a small fine.

However, issues of censorship in the classroom are very much contemporary. In 1987 (Edwards v. Aguillard) the Supreme Court struck down a Louisiana law requiring that creationism be taught together with the theory of evolution. By debating the issues themselves, students should become more aware that what may or may not be appropriate to learn about in public school classrooms can be a highly controversial subject. How are such decisions arrived at? What about the dissenters (whether they be judges, parents, teachers or students)?

There are additional cases related to issues raised in the Scopes trial which can be considered as well. What happens when parents object to a New York Board of Education's attempt to remove certain books from the library at the request of other parents (Board of Education v. Pico, 1982)? Nine books were actually removed from a high school library because they were considered morally and/or politically objectionable. Was this allowed under the Constitution? Students might consider some of the titles and content of these books and deliver their own "verdicts". Also, what happens if family-religious values conflict with state school requirements (as in Yoder v. Wisconsin, 1971) when Amish families objected to their children remaining in school until the age of sixteen?

In 1988, near St. Louis, a high school principal censored the school newspaper, and removed articles about teenage pregnancy, birth control and the impact of divorce on children (Hazelwood School District v. Kuhlmeier). Was this allowed under the U.S. Constitution?
Students who have participated in this issue-oriented debate over curriculum in the public schools have had their awareness heightened and their interests kindled. They have learned that Constitutional issues may affect them personally, discussion of issues can be quite emotional, and that court decisions may not satisfy everyone.

I. UNIT OBJECTIVES

This unit of study contains certain basic concepts associated with the topic which students will be expected to understand and use:

Student Vocabulary List

The following is a list of concepts and ideas students should be familiar with after having completed this unit of study:

American Civil Liberties Union
adjourn
*amicus curiae*
appeal (Appellate Court)
arrest
Attorney General
bail
balanced treatment act
bill
Butler Act
case
checks and balances
civil law
counsel
court record: off the record
court record: on the record
Genesis
grand jury
impartial
indictment
jury selection
constituency (of laws)
conviction
creation-science
criminal law
cross-examination
Darwinism
defendant
defense
dissenting opinion
evidence
evolutionary theory
exception (in court)
felony
fine (by jury or court)
fundamentalism
plea
peremptory challenge
preliminary hearing
prohibit
prosecution
During this prepared unit of study, students will be assigned to carefully examine court records, testimonies of witnesses and court opinions in an effort to involve them in the legal process and how it operates. They will follow a bill from its inception to its challenge in court, right through to the appeals stage.

This unit has challenged students to develop and use certain critical thinking skills. Students can, if the teacher so desires, become involved in several learning activities that will challenge them to read factual evidence carefully and analyze this evidence in ways that will enable them to become more coherent thinkers and writers. By debating legal issues with their classmates, students learn to improve speaking and listening skills, as well as small group process skills. In summary, students who complete this unit of study will have been exposed to methods which are intended to improve their abilities to decipher, interpret, organize and communicate information more effectively.

In addition to skill-building, students will become familiar with terminology relating to law and the courtroom. Students will be expected to keep lists of vocabulary words and concepts within their groups. Glossaries are available for them to consult. Independent research is encouraged. The teacher hands out specific questions to answer based on group readings to help students accurately summarize facts.

II. UNIT SUMMARY AND STRATEGIES

To introduce the unit to the students, I have taken information from a 1981 court case, *McClen v. Arkansas*, which challenged a “balanced treatment” law
allowing Creation-science and Evolution-science to be taught in Arkansas' public school classrooms. On Day One of the unit, I introduce a role play involving an imaginary biology teacher. This science teacher is required by law to teach Darwin's theory of evolution to his students. He does not believe that evolution should be taught all by itself, without a "balanced treatment" given to the Bible-Creation explanation, a belief both he and many of his students share. But there is nothing mentioned in the science textbook about Bible-Creation, only evolution. His principal warns him to "stick to the textbook." He is not sure what to do. He has four alternatives: (1) teach evolution only; (2) teach Bible creation only; (3) teach both; (4) teach neither.

Following a discussion of the issues and after having been given a "Fact Sheet" on both Creation-science and Evolution-science, (see Lesson Plan section below) students are put into discussion groups with the purpose of preparing a recommendation to the "School Board." After hearing the recommendations, the Board will recommend a policy to be followed in all science classes. This activity is geared toward familiarizing students with concepts such as "balanced treatment," evolution and creation-science, but, more importantly, for them to see that many ideas for laws and litigation arise out of ordinary experiences.

The next class period, after hearing from the "School Board," we learn that a "Balanced Treatment" Act has been challenged in court and has been struck down. Students will then hear the court's reasons, which relate to First Amendment protections against establishment of a religion. Is this censorship? Students will be encouraged to discuss their views on forms of censorship carried on in public schools and the "reasonable limits" of such censorship. Who has the right to censor? Can policies and laws be challenged? If so, how? This should lead us into our assignment for the next several days, the issues surrounding the case of Tennessee v. John Thomas Scopes, the so-called "monkey trial" held in Dayton, Tennessee in July, 1925, in which a science teacher was arrested for teaching evolution in violation of the state laws at that time.

**TENNESSEE V. JOHN THOMAS SCOPES**

For the next five to six class periods the students will study the famous case as a way of understanding the legal process. To begin, we will examine the bill presented by Tennessee representative John Washington Butler. Butler was a second-term legislator and was concerned about reports that the teaching of
Charles Darwin's theory of evolution in Tennessee schools was causing disbelief in the Biblical account of creation among young people.

Why had Butler sponsored such a bill? Butler firmly believed that:

In the first place, the Bible is the foundation upon which our American Government is built . . . The evolutionist who denies the bible story of creation, as well as other Biblical accounts . . . robs the Christian of his hope and undermines the foundation of our Government.

(Quoted in Ginger, *Six Days or Forever?*, 4)

The bill was referred to committee, and was passed by the lower house by a vote of 71 to 5.

Then it was the senate's turn. The bill in the senate was promoted, among others, by former Secretary of State and three-time Presidential candidate William Jennings Bryan, who would later participate as a special prosecutor in the Scopes trial a few months later. Bryan had helped successfully to sponsor an anti-evolution bill which had become law in Florida two years earlier. Bryan's view was that evolution, if taught, should be recognized for what it was, a series of educated guesses.

The Senate passed the bill with little opposition by a vote of 24 to 6, exactly as written by John Butler. (See Appendix, Document 1.) Eight days later, Governor Austin Peay signed the bill into law, fully expecting that the law would not effectively change science teaching in Tennessee. (Appendix, Document 2.) The Butler anti-evolution Act was now law. Would it be enforced? Would there be a test case? Tennessee and the world did not have long to wait for an answer.

**THE DEFENDANT: JOHN THOMAS SCOPES**

According to John Scopes, he agreed to stand trial as a result of a drugstore discussion that got out of hand. More than one observer has concluded he was snared into it by those seeking publicity for their hometown of Dayton. A mining engineer named George Rappleyea, a native New Yorker, had been reading in the newspaper that the American Civil Liberties Union in New York was willing to supply a defense team of distinguished lawyers to handle a test case of the recently passed anti-evolution law in Tennessee, the Butler Act. Rappleyea thought immediately of Dayton's new science teacher and football coach, Scopes. Two days later, a meeting was arranged after school at F.E. Robinson's
drugstore, and during the debate over evolution. Scopes admitted that he did not see how it would be possible to teach biology without mentioning Charles Darwin's theory. In fact, he said, the Tennessee-approved textbook, used in Dayton, Hunter's Civic Biology, contained a chapter on the evolution of man and Darwin's theory of natural selection.

Scopes admitted he was opposed to the Tennessee anti-evolution law because he did not think that the state should tell all the Tennessee schools what could and could not be taught, that was a matter for a local or county school board, not the state. After some more discussion, Scopes agreed to be arrested; and on May 10, 1925, he was given a preliminary hearing before three judges. It was charged that he had taught the theory of evolution to his class on April 24 from Hunter's Civic Biology textbook, which contained sentences such as: "We have now learned that animal forms may be arranged so as to begin with the simple unicelled forms and culminate with a group which contains man himself." (Appendix, Document 4) A grand jury was scheduled to meet to formally indict Scopes. Bond was set at $1,000, and was paid by Robinson and Rappelyea. The grand jury met on July 10, one month earlier than scheduled, just to make sure that Dayton would get the test case publicity.

Meanwhile, Scopes had been invited to New York City to meet with the A.C.L.U. to choose counsel and plan legal strategy. Scopes was very pleased that the famous trial lawyer Clarence Darrow had volunteered his services for this case. Assistance would be given by Dudley Field Malone and Arthur Garfield Hays, two other well-known attorneys. Three other lawyers represented Scopes, including a Tennessee law professor John R. Neal, who was placed in charge of the case.

THE TRIAL ITSELF

I. Day One: July 10 (Friday)

Court was called to order promptly at 9:00 A.M. by Judge John T. Raulston. The defendant, John T. Scopes was there with his six attorneys, including Darrow and two other lawyers, Malone and Hays, from outside of Tennessee. They were introduced to the court by the chief counsel, Mr. John Neal. The prosecution was represented by A.T. Stewart, the attorney-general, Ben McKenzie, McKenzie's son Gordon, and five other lawyers, including William Jennings Bryan. Bryan, it should be noted, had a special interest in this case, since he had helped to draft Tennessee's anti-evolution bill. He was a staunch defender of fundamental Bible beliefs. More than one hundred reporters and two from London,
England, sat at the press tables. The courtroom was bulging with over four hundred spectators who lined the walls. The judge asked that the session be opened with prayer, as he did throughout the trial.

A new indictment of Scopes had to be handed down, since the first indictment was done so hurriedly on May 25. Quickly, the first order of the court was to impanel a new grand jury and read them the anti-evolution statute that Scopes allegedly had violated. (Appendix, Document 1)

He then read from Genesis, Chapter One, containing the divine story of creation in the Bible. "And God created man in his own image, in the image of God created He them, male and female, created He them." (Appendix, Document 3)

The judge went on to explain that the issue before the grand jury was not the wisdom of the Butler Act, but whether there had been a violation of it. If so, after an impartial examination of evidence (three of Scopes' students had to be rounded up in order to give statements to the jury), it was found that the teacher broke the law, then it was their duty to return a report to the judge so stating. By 11 A.M. the grand jury returned an indictment. Now at last the case of Tennessee v. John Thomas Scopes, No. 5232, could begin.

Before the selection of jury members for the trial to begin, Darrow wanted to know if and when his scientists were going to be able to testify for the defense. This question was a major issue before the court: Could the defense try to prove in the trial that the theory of evolution was a valid scientific proposition, and that it did not necessarily negate the teachings of the Bible? Or would the scope of the case be narrowed to the simple violation of the Butler Act?

Judge Raulston then ordered the selection of jury members to begin, even though a jury pool of only sixteen men was present. Darrow was shocked that the judge expected the jury to be impaneled in one afternoon; why there were times when two hundred veniremen and several weeks were needed to select a satisfactory jury.

The jury selection process which followed was quite fascinating. And it was complete by the end of the afternoon, much to everyone's surprise. In order for students to more completely understand this segment of courtroom procedures, students may participate in a role play, where potential jurors are interviewed by the defense and prosecution attorneys, each with varying viewpoints toward either evolution or the Bible. In this way, with role-playing attorneys given only two peremptory challenges, the students will heighten their awareness not only of how jury selection works but also the issues at stake in the Scopes case. (Appendix, Document 7)
After accepting the first and second jurors, Darrow interviewed an ex-miner now a farmer, Jim Riley. Darrow inquired as to whether he had ever talked to anyone about evolution or heard any sermons about it. Riley said no.

DARROW: Ever hear Mr. Bryan speak about it?
RILEY: No, sir.
DARROW: Ever read anything he said about it?
RILEY: No, sir; I can't read.
DARROW: Well, you are fortunate. (Laughter)

(Quoted in Ginger, 98)

Riley was accepted, along with eight other farmers; two were landowners, and one a shipping clerk.

During the questioning, Darrow revealed that his strategy was to contend that evolution did not necessarily contradict Genesis, and therefore under the wording of the Butler Act, establish that his client, Scopes, may only have partially broken the law: the part that said it was forbidden to teach, “any theory that man has descended from a lower order of animals.” According to the defense motion, Scopes would have to commit two separate acts to be fully guilty under the law, the other act being that, “any theory that denies the story of the Divine Creation as taught in the Bible”, is illegal. Was this the lawmakers’ original intent, or just legal “hairsplitting?” The court would have to rule on this motion (See Day Four of the trial).

II. Day Two: July 13 (Monday)

Court was delayed for a few minutes so that the radio microphones could be adjusted. Judge Raulston commented proudly, “My gavel will be heard ‘round the world.” After prayer, attorney-general Stewart read the indictment against Scopes, followed by defense attorney Neal's motion to quash the indictment.

The prosecution argued 1) that freedom of religion applied only to worship in churches, and 2) that it had been established by the U.S. Supreme Court (Meyer v. Nebraska) recently that a legislature had power to control public school curriculum. To the prosecution it was a simple matter:

B. MCKENZIE: Under the laws of the land, the constitution of Tennessee, no particular religion can be taught in the schools. We cannot teach any religion in the schools, therefore you cannot teach any evolution, or any doctrine that conflicts with the Bible. That sets them up exactly equal...
As to the clarity of the statute (McKenzie continued):

Under the law you cannot teach in the common schools the Bible. Why should it be improper to provide that you cannot teach this other theory? (Grebstein, 57)

Was evolution, then, to be construed as a set of "religious beliefs?" This same question would recur fifty years later in similar cases argued before the United States Supreme Court. (See "Two Modern Cases" below)

After the prosecution made its major point, that is, that the state has a duly constituted authority and legal responsibility to prescribe the curriculum for the public schools, Darrow got his chance to reply. His sarcasm was evident:

As hard as it is for me to bring my mind to conceive it, almost impossible as it is to put my mind back into the sixteenth century, I am going to argue it as if it was serious, and as if it was a death struggle between two civilizations. (Grebstein, 60)

He was finished, and court adjourned for the day.

III. Day Three: July 14 (Tuesday)

After a third straight day of opening court with prayer, Darrow opened another assault on the court, demanding that prayer be removed from the courtroom, since the case pitted science against religion and this might prove an undue influence on the jury. Judge Raulston ruled that prayers would not unduly influence him or the jury, so the prayers would continue.

Was it science versus religion? Academic freedom versus the right of the state to standardize the curriculum? A simple matter of a state law being violated by a high school science teacher? The judge refused to rule on these matters until the next court session. Everyone was getting impatient, especially the jury members, who had been barred from the courtroom for two days. When, if ever, would they be allowed to hear the arguments that would decide the fate of John Scopes?

IV. Day Four: July 15 (Wednesday)

It took the judge an hour to read his 6,000-word statement denying the defense motion, stating that the intent and wording of the Butler Act was clear, that the state had a constitutional right to determine what was (and what was not) taught in the public schools, and any teacher who wanted to teach evolution was free to teach it in the private schools or elsewhere. Fur-
thermore the Butler Act did not force religious beliefs on anyone. Sobeit. The court had spoken.

A rousing victory for the prosecution. The trial would proceed. The jury would be sworn in.

After a recess until 1 P.M., the court was to hear the only testimony that became part of the official court record, even though the trial would last eight days.

After the plea of Not Guilty was entered by the defense, a brief statement followed by the attorney-general, Mr. Stewart, stating that Scopes had violated the state law by teaching that man had descended from "a lower order of animals."

With the jury still not present, Mr. Malone gave the defense's opening statement in which he maintained: (1) there was no direct conflict between the theory of evolution and the theories of creation in Genesis; (2) stories of creation in Genesis were not scientifically correct.

After the jury was seated, Howard Morgan, fourteen, and one of Scopes' science students, testified that his teacher had taught that man was a mammal and that life gradually had evolved from the sea. A sample of the cross-examination by Darrow:

Q: He didn't say a cat was the same as a man?
A: No sir; he said man had a reasoning power; that these animals did not.
Q: There is some doubt about that, but that is what he said, is it? . . .
Q: Well, did he tell you anything else that was 'wicked'?
A: No, not that I remember of.

This exchange caused even members of the prosecution to grin.

Q: Now, that is about what he taught you. It has not hurt you any, has it?
A: No, sir.

(Grebstein, 102, 103, 105)

After hearing from another of Scopes' students, Harry Shelton, the prosecution called F.E. Robinson, the school board member who had ordered the biology books used by Scopes. Darrow, in cross-examination, established that Scopes' textbook, was indeed approved by the state.

Darrow then read to the jury from the textbook the reasons why man was classified with the vertebrates, then the mammals, then with the apelike mammals. Not to be outdone, Stewart read into the record the first two chapters of Genesis. Balanced treatment. The state's case was officially over; Bryan had not even made a statement!

The defense began its case after being allowed to swear in ten witnesses, nine of them distinguished scientists, all scheduled to testify as to the validity of evolution. The first witness sworn in was Dr. Maynard Metcalf, a zoologist, author and member of a Congregationalist church.
Was evolution a fact, he was asked?

The whole plan of evolution . . . seen so clearly in the universe as a whole, makes a tremendous probability in favor of the evolution of man (Grebstein, 115, emphasis added)

Scientists, Metcalf insisted, disagreed that the evolution process was a “fact,” but he doubted “the truth of any hypothesis—as to the methods of the evolution which this or that or the other man—even great men of science—might bring up.” Inconclusive testimony at best. As it turned out, it was the only testimony on evolution the jury was to hear, from a scientist, at least.

V. Day Five: July 16 (Thursday)

After prayer, the question before the court was this: whether to uphold the state’s motion to exclude all scientific experts testimony on the truth or the falsity of evolution. W. J. Bryan, Jr., made the point that expert testimony would be only opinion, not fact.

According to the state, since Scopes had taught that man had descended from a lower order of animals, he had denied the Bible’s account of Creation. After lunch, William Jennings Bryan made his first speech. For an hour he warned of the evils of evolution and the truth of the Bible. And what of the children?

BRYAN: Why, my friends, if they believe it, they go back to scoff at the religion of their parents: And the parents have a right to say that no teacher paid by their money shall rob their children of faith in God and send them back to their homes, skeptical, infidels, agnostics or atheists. (Grebstein, 127)

After a short recess, Malone made a long emotional speech to the court, in which he made an impassioned appeal (1) to recognize the Bible as a book on religion not science; (2) to realize there is no major conflict between Bible creation and evolution; (3) conclude that the truth could only be known if scientific testimony were allowed. On this last point Malone pleaded: “Is our only weapon—the witnesses who shall testify to the accuracy of our theory—Is our only weapon to be taken from us, so that the duel will be entirely one-sided?”

VI. Day Six: July 17 (Friday)

In perhaps the most dramatic statement yet made at the trial, Judge Raulston revealed that his thinking had remained unchanged. “It is not within the province of the court under these issues to decide and determine which is true,
the story of divine creation as taught in the Bible, or the story of the creation of
man as taught by evolution.” No experts were needed to comprehend the simple
language of the law; no scientific testimony would be heard. The result: pande-
monium in the courtroom. When order had been restored, the two sides bristled
at each other. A sample follows:

HAYS: We say that it is a denial of justice not to permit the Defense to make
its case on its own theory.

COURT: Let the exception be entered of record.

STEWART: I desire to except to exceptions made in that manner . . . I think
it is a (poor) reflection on the Court . . .

COURT: Always expect this Court to rule correctly.

DARROW: No sir, we do not. (Laughter)

COURT: I suppose you anticipated it? (my ruling)

DARROW: Otherwise we should not be taking our exceptions here, your
Honor. We expect to protect our rights in some other Court. Now that is
plain enough, isn’t it? . . . I do not understand why every request of the State
and every suggestion of the Prosecution should meet with an endless
amount of time, and a bare suggestion of anything that is perfectly compe-
tent on our part should be immediately over-ruled.

COURT: I hope you do not mean to reflect upon the Court?

DARROW: Well, your Honor has the right to hope.

(Grebstein, 137)

Raulston was clearly angered and said to Darrow: “I have a right to do some-
thing else, perhaps.” The crowd waited to see if the Judge would send Darrow to
jail for contempt. But the Court did nothing. Instead he adjourned the court
until Monday.

VII. Day Seven: July 20 (Monday)

Monday’s session began abruptly. Judge Raulston immediately cited Darrow for
contempt of court for remarks expressed on Friday to the court that were “con-
temptuous and insulting.”

After lunch, Darrow made a statement to the court apologizing for his ill-
mannered remarks on Friday. The Judge, in the name of Christ, forgave Darrow
and accepted his apology with these words, "we forgive him and we forget it, and we commend him to go back home and learn in his heart the words of the Man who said: 'If you thirst come unto Me and I will give thee life.' " (Quoted in Grebstein, 143) The courtroom applauded, as they had Darrow when he had finished his remarks. At this point, Judge Raulston announced that cracks had developed in the ceiling beneath the courtroom. He was fearful that the building would collapse, so he ordered court to convene outdoors for the afternoon session. The evidence by scientists continued to be read into the record (approximately 35,000 words altogether from seven scientists).

Next, the Judge agreed to have a large sign saying "READ YOUR BIBLE" removed from the courthouse, near where the absent jury was scheduled to sit. Again the judge wanted to appear as "fair" as he could.

Then, the surprise move by the Defense came: they wanted to call William Jennings Bryan as a witness, an expert witness on the Bible! The judge hesitated, the Prosecution objected, but Bryan seemed afraid not to. How could he refuse to give battle? He looked to the Judge to save him, but Raulston seemed to welcome the opportunity, giving Bryan permission to call Darrow to the witness stand as well. That opportunity was to be denied Bryan, however. And Darrow was to have the opportunity he had been waiting for since the trial began—to attempt to make a "monkey" out of Bryan.

Throughout the questioning, Darrow relentlessly pointed to miracles that, he said, could not have happened in a scientifically ordered world. Bryan replied, "One miracle is just as easy to believe as another." Darrow was frustrated at Bryan's refusal to give exact answers. He got angrier.

DARROW: What do you think?
BRYAN: I could not say.

DARROW: (Was the estimate of the time of the flood figured out) from the generations of man?
BRYAN: I would not want to say that.

DARROW: What do you think?
BRYAN: I do not think about things I don't think about.

DARROW: Do you think about things you do think about?
BRYAN: Well, sometimes.

(Grebstein, 151)
At this even the judge joined in the laughter. And despite objections for the questioning to stop, Bryan remained, insisting that the defense had “no other purpose than ridiculing every Christian who believes in the Bible.” Darrow’s response to Bryan: “We have the purpose of preventing bigots and ignoramuses from controlling the education of the United States and you know it—and that is all.”

Bryan’s final retort: “I am simply trying to protect the word of God against the greatest atheist or agnostic in the United States. (prolonged applause from the crowd) I want the papers to know I am not afraid to get on the stand in front of him and let him do his worst.” (Grebstein, 164)

The questions continued. More arguing. Bryan did admit that the “days” in Genesis, he thought were “periods of time” not necessarily literal twenty-four hour days, but he “would not attempt to argue against anybody who wanted to believe in literal days.”

The testimony, which had lasted for over an hour and a half, was the “event” everyone had hoped for. The questioning ended with both men trading insults, and Bryan, obviously exhausted and trembling, was still willing to continue until Darrow was satisfied.

BRYAN: I want the world to know that this man, who does not believe in a God, is trying to use a court in Tennessee—

DARROW: I object to that.

BRYAN: (continuing) to slur at it, and while it will require time, I am willing to take it.

DARROW: I object to your statement. I am examining you on your foolish ideas that no intelligent Christian on earth believes.

(Grebstein, 169, 170)

Darrow had the final slap in the face. Court was adjourned until 9 A.M. Tuesday.

VIII. Day Eight: July 21 (Tuesday)

The Judge announced that Mr. Bryan’s testimony the previous day would have no relevance to deciding the case either in this court or the appeals court, so therefore he was eliminating it from the court record. The jury would not consider it as evidence.
The jury was brought in for the first time in days, and Darrow read his charge to the jury, saying that this case could only be settled in a higher court, "and it cannot get to a higher court unless you bring in a (guilty) verdict." He was telling the jury he wanted them to find the defendant, Scopes, guilty!

Raulston explained that the fine, if the jury found Scopes guilty, should be set by the judge, unless they wanted to impose a fine of more than $100.00; otherwise they could just find the defendant guilty "and leave the punishment to the court."

The jury retired for awhile and after nine full minutes returned with a verdict. Guilty. They left the matter of a fine to the court. The defendant, Scopes, silent throughout the trial, rose to face the judge, who imposed the minimum $100.00 fine. Finally, Scopes was allowed to make a brief statement:

Your Honor. I feel that I have been convicted of violating an unjust statute. I will continue in the future, as I have in the past, to oppose this law in any way I can. Any other action would be in violation of my ideal of academic freedom — that is, to teach the truth as guaranteed in our constitution, of personal and religious freedom. I think the fine is unjust. (Grebstein, 176)

The judge then allowed some closing remarks from the various participants. The attorneys remarked on the hospitality of the judge, and the people of Tennessee; everyone seemed gracious and in good spirits. Even Darrow, humorously thanked the judge for his kind treatment in not having sent him to jail. Bryan gave a brief summary of the trial's significance:

Here has been fought out a little case of little consequence as a case, but the world is interested because it raises an issue, and that issue will some day be settled right, whether it is settled on our side or the other side . . . . The people will determine the issue. They will take sides upon this issue; they will examine the information . . . and the facts will be known, and upon the facts, the decision will be rendered . . . No matter what our views may be, we ought not only desire, but pray, that that which is right will prevail, whether it be our way or somebody else's . . .

The judge put it this way:

Now my friends, the man . . . who is big enough to search for the truth and find it, and declares it in the face of all opposition is a big man . . . Now, my friends, the people in America are a great people. We are great because we are willing to lay down our differences when we fight the battle out and be friends. (Grebstein, 178, 180)

Following the benediction, the court was adjourned.
Finally, there was an appeal to the Tennessee Supreme Court, heard six months later, and argued by the same A.C.L.U.-sponsored lawyers for Scopes. Obviously, Bryan could not participate, since he had died on July 26, 1925, five days after the trial ended.

In his ruling, seven months later, on January 14, 1926, Chief Justice Green claimed that the Butler Act was clear in its meaning and intent and that it, indeed, was constitutionally valid. As for Scopes, due to Judge Raulston’s setting of Scopes’ fine rather than the jury, the verdict was reversed on a legal technicality. No further appeal was possible because of the judge’s error, so the case was thrown out of court. Motions for a new hearing were denied. One justice of the court dissented from the majority ruling because he felt the Butler Act was vague and unclear and should have been struck down for that reason.

**SCOPES CASE: ISSUES FOR DEBATE**

What was the significance of Dayton, Tennessee, July, 1925? Was it a carnival? A rural sideshow? An anachronism? Or, as one observer put it, was it “a great historic guidepost on the road to emancipation in the search for truth?” (Tompkins, ed., *D-Days at Dayton, 63*)

Who won the Scopes case? There were, of course, differing opinions. An Oklahoma paper declared: “Mr. Bryan came out more than victorious. He made a monkey out of the defense counsel and left them gasping.” In Little Rock, Arkansas, the Gazette reported, “For the state of Tennessee the Scopes trial has been a moral disaster. It will plague the citizen of Tennessee wherever he may go.” Dudley Malone, the Defense attorney, said the trial had been a “victorious defeat.” Students, having read and discussed most of the testimony of the trial, will be assigned to debate orally one of three positions on the following resolution:

RESOLVED, that the Scopes trial was a clear victory for the Anti-Evolutionists.

The three positions will be the Affirmative (agrees with the resolution), the Negative (disagrees with the resolution), and the Middle Position (sees elements of victory for both sides). From the very beginning of the Scopes case, students should know which position they will be defending, and should be gathering “evidence” for their point of view.

Following the classroom debate, students should view the film “Inherit the Wind” (videocassette available through the Institute office or your local Video
store) in whole or in part, for the students' critical analysis (See Appendix for "Student Worksheet"). If time permits only one class period, begin showing from Day Seven of the trial, the day that Bryan takes the stand, the obvious climax of the film. Students should note how the film differs from historical fact and try to determine why the playwrights did so. Was the film in any way "biased" for or against either side in the case? Good insights should be gained from this class activity and critical thinking skills sharpened.

TWO MODERN CASES

To wrap up the unit, a discussion of issues in two modern cases brings the issues in controversy into the present. In McClean v. Arkansas (1982) the U.S. District Court decided to strike down, on constitutional grounds the Arkansas “Balanced Treatment Act” (Act 590) enacted by the General Assembly in March, 1981. The Act stated:

Balanced treatment shall be given in the public schools within this State . . . to the extent that (teaching methods) deal in any way with the subject of the origin of man, life, the earth, or the universe. Treatment of either evolution-science or creation-science shall be limited to scientific evidence for each model . . . and must not include any religious instruction or references to religious writings . . .

Further the act required “instruction in both scientific models if public schools choose to teach either.” (italics added)

The emphasis appeared to be toward offering students the benefit of two models: “This legislature enacts this Act for public schools with the purpose of protecting academic freedom for students’ differing values and beliefs . . . This legislature does not have the purpose of causing instruction in religious concepts or making an establishment of religion.” (Quoted in LaFollette, ed., Creationism, Science and the Law, 15, 16, 17)

Nevertheless, with all its apparently “good motives,” the Arkansas “Balanced Treatment Act” was struck down as an attempt to bring “religious instruction into the classroom.” The court’s conclusion in a lengthy decision and after months of testimony, concluded that “The First Amendment principles are not determined by public opinion or by a majority vote . . . No group, . . . may use the organs of government, of which the public schools are the most conspicuous and influential, to foist its religious beliefs on others.” (Quoted in LaFollette, 72)

Despite the gains at respectability made by creation-scientists, this decision had a devastating effect on their credibility. The question troubling many non-
scientific laymen remains: Isn’t the court, by prohibiting creation-science from the classroom, exercising a form of censorship which denies students and teachers “academic freedom?”

These issues surfaced again, this time in Louisiana, with a court challenge to its 1981 “Balanced Treatment Instruction Act.” This time, the appeal went all the way to the top of the judicial ladder. The U.S. Supreme Court decided, in June, 1987, by a vote of 7 to 2, to strike down the Louisiana statute. Edwards v. Aguillard featured a high school science teacher, who, along with parents and other colleagues, won victories in two lower federal courts before the big victory in Washington, D.C.

And so, another round has been fought in the science v. religion controversy. Will there be a next round? Some, in 1925, didn’t think so, but they were proven wrong. Can religion and science be reconciled in certain areas? Do they have to “agree to disagree” in others?

A scientist who testified in the Scopes trial brought the issue forward this way:

Neither the right kind of mind (scientific) nor the right kind of heart (religious) will suffice without the other. Both are needed if civilization is to be saved. (Quoted in Tompkins, ed., 167)

III. SAMPLE LESSON PLANS

Lesson One: Freedom to Teach, Freedom to Learn? (Two Days)

Objectives:
1. To involve students in the contemporary debate over academic freedom v. censorship in public schools;
2. To acquaint students with the concept of “balanced treatment;”
3. To allow students to explore possible solutions to conflicting ideas and beliefs; particularly those that affect students in schools.

Procedures:
1. The classroom teacher introduces a dilemma (Day One) to the class: that of a high school biology teacher who believes that his students should know that there are two possible explanations to the origins of the universe and of plant and animal life. However, only one, evolution, is discussed in the textbook. The principal tells him to “teach what’s in the book—period.” He is troubled by this and believes he has a good case, since many of his students and their parents are persuaded that “Creation-Science” should also
be taught, alongside of “Evolution-Science”. He decides to take it to the Board of Education meeting for them to decide.

2. Students are divided into three groups. Each is given a “fact sheet” (below). The three groups discuss among themselves what they will present to the Board members tomorrow. The alternatives are: (1) teach evolution only (the textbook); (2) teach creation-science only (ignore the textbook); (3) teach both evolution and creation-science.

3. The teacher should answer questions about various terms, but remember that this exercise is one in problem-solving; the technical difficulties of this issue as a legal problem will be discussed later.

4. If there is time, tentative conclusions may be shared among the entire class.

5. Assignment: Poll at least five adults on this issue and be prepared to report findings tomorrow.

Lesson One: “fact sheet”: Evolution-Science and Creation-Science

Directions: After reading this “Fact Sheet,” discuss in your group your recommendations to the Board of Education. What should students study in science class?

Evolution-Science:

1. The earth is millions, perhaps billions of years old; it has to be that old in order for the slow evolutionary changes to take place;

2. The universe at first was in a state of disorder and non-living material; it has evolved (changed) over millions of years into one of order and life has emerged from non-life;

3. Life in early stages was simple; the present living kinds have developed from processes known as “mutation” and “natural selection;”

4. Man has emerged from an ancestor common to apes;

5. Reliance on rocks and the fossil record to show that later species are related to earlier species, now no longer living (extinct).

Creation-Science:

1. The earth is relatively recent; its age can be measured in thousands of years;

2. The universe was created suddenly, energy and life came from nothing (there was no pre-existing matter prior to “creation”);
3. Basic changes have not occurred in animal and plant kinds, only within certain limits;
4. Separate ancestry of man and apes;
5. Explanation of the earth's rock and fossil record by catastrophic events, including worldwide flood;
6. Denial that "mutation" and "natural selection" can explain the great variety in plant and animal kinds from a single organism.

**Arguments: Evolution v. Creation-Science**

1. Creation-Science is a religious belief and therefore cannot be introduced in public schools because the Constitution forbids the government to pass laws which promote particular religion.
2. Creation-Science advances beliefs from Genesis in the Bible.
3. Creation-Science is really religion and not science.
4. Creation-Science would force students to make a false choice between "religion" and "science", keep religion out of science classes.

**Arguments: Creation-Science v. Evolution (for "balanced treatment")**

1. Creation-Science's purpose is to deal with the issues of origins of life on a scientific basis, with no references to the Bible or religious doctrine.
2. The universe is very complex and orderly; could it all just have happened, without the outside power and plan of a Creator?
3. Evolution is merely a theory; since there are only two possible explanations for the origins of the universe and life on earth, why not expose the students to both, rather than one explanation?

**Sources:**

Montagu, Ashley, *Science and Creationism*
LaFollette, Marcel, *Creationism, Science and the Law*

**Lesson Two: The Scopes Trial: Issues and Answers**

**Objectives:**

1. To familiarize students with issues of law, particularly the issue of First Amendment rights and how they may or may not pertain to the classroom situation;
2. To become more aware of actual courtroom procedures and terminology (e.g., cross-examination, grand jury, indictment, etc.);
3. To sift through the issues present in the Scopes case;
4. To try to understand why some court cases receive so much publicity and others do not;
5. To involve students in the processes of courts through role plays, mock interviews and film.

**Procedures:**
1. As students read the actual day-to-day happenings of the case (see above), certain "key questions" should be referred to (below) and have students prepare answers ahead of time for discussion in class.
2. Issues discussed: Examine the Documents (found in the Appendix) One and Two, to try to get students to understand what the Butler Act really said (is it clear?) and what the Governor said about it. What is the students' opinion of the law? (This law is actually still on the books in Tennessee; an attempt to repeal it in 1951 was defeated.) Who in 1925 would be happy about such a law? Who would be unhappy? What could a science teacher do about such a law? What if he or she broke the law?

**Assignment:** Examine Documents 3 and 4 (see Appendix). What conflicts, if any, do you see in these two pieces of historical evidence? Why would people criticize either one?

**Procedures:** (Day Two)
1. After discussing issues raised by last night's assignment, focus on the person John Scopes (Read selection in class provided in unit above). Have students discuss who he was, what he believed in, how it all happened that he became the defendant in a famous trial. How do the students react? Would they want to be Scopes? Why or why not?
2. Next hand out Documents 5 and 6 (see Appendix), edited documents from the First Day of the trial. Notice all the names of attorneys. How does court open? What does this tell you? Read carefully what the judge says to the grand jury members. If you were a member of the grand jury, how would you decide? Why?

**Assignment:** Examine Document 7 to prepare for tomorrow's class, a Role-Play (optional) in selecting a jury for the Scopes trial: interviewing potential jury members. Question (Document 7): Would you have done what the Defense Attorney, Darrow, did at the end of this interview (he rejected the jury member)? Explain.


Procedures: (Trial Questions)

As students read the selected information about the trial, be aware of issues and terminology which will help students understand and appreciate the worldwide attention this trial was getting in the media. How might they have “covered” the trial? What kinds of stories might they have written?

Lesson Three: Inherit the Wind (Film on Videocassette)

Objectives:

1. To observe, in dramatized form, the issues brought out by the Scopes case;
2. To encourage students (as a test of their knowledge of facts about Scopes) to differentiate between historical fact and dramatic fiction;
3. To look for bias on the part of those writing or producing the movie.

Procedures:

1. Before viewing the film, explain that names have been changed to fictitious ones:
   - William J. Bryan (Matthew Harrison Brady)
   - Clarence Darrow (Henry Drummond)
   - John Scopes (Bert Cates)
2. Hand out “Student Worksheet” (included in unit) for students to use as they watch the film.
3. Note: If time allows you to show part of the film only, then start with the beginning of the Seventh Day of the trial, which features the interrogation of Brady (Bryan) by Drummond (Darrow).

Student Worksheet: Inherit the Wind

Introduction

Now that we have studied the issues and personalities in the famous Scopes case, we will view a dramatization of this trial. As in the Scopes case the defendant (Bert Cates) is arrested for violating the state law that made it a crime to teach any theory that contradicts the Bible. The defendant is represented by a famous trial lawyer (Henry Drummond) from Chicago, a religious agnostic. Another of the defense supporters is a journalist (E.V. Hornbeck), who does not take the trial seriously at all. The minister’s daughter (Rachel Brown), who is the defendant’s
fiancée, is called as a prosecution witness in the trial by the prosecution attorney (Matthew Harrison Brady). Brady is a former candidate for President, a Bible expert and a supporter of conservative views and the “common man.”

**Discussion Questions**

As we view the film, be prepared to discuss the following:

1. The journalist Hornbeck describes the trial as the “Persecution of the educated.” What do you think he meant by this statement? Do you agree or disagree with his opinion?
2. What role did the media play in the trial (both newspapers and radio)? Compare this to the role of the media (TV included) in recent trials or Congressional hearings. Why was this trial a “media event”?
3. Comment on the statement made by the defense lawyer Drummond, “Right has no meaning to me whatsoever. Truth has meaning as a direction.” What does he mean by this difference?
4. What is the meaning of the Bible verse which has provided the film’s title, found in Proverbs 11:29? “He that troubleth his own house shall inherit the wind; and the fool shall be servant to the wise of heart.” How can it be applied to the dramatic events?
5. How is the word “evolution” used in explaining change?

**Observation Questions**

The authors of the play, Jerome Lawrence and Robert E. Lee, insist their play “is not history.” Try to correct the fictitious parts of the play as you remember them from your study of the Scopes trial. Complete the chart below (add others):

**Fiction:**

1. Bert Cates is arrested and dragged from his classroom, led by the minister and the mayor.
2. Henry Drummond stands alone in his defense of Bert Cates.
3. F.V. Hornbeck’s newspaper, the *Baltimore Herald*, arranges for Henry Drummond to defend Cates and pay all legal fees.
4. Testimony by all scientific experts is completely ignored by the judge.
5. Other observations you may have noticed:

**Thought Question:** Why change the facts at all? What purposes might the authors have in mind in altering the historical facts of the case?
APPENDIX

Teaching Materials useful in teaching Scopes

Document 1: The Butler Act, 1925

Section 1. Be it enacted by the General Assembly of the State of Tennessee, That it shall be unlawful for any teacher in any of the Universities, Normals (high schools) and all other public schools of the State . . . to teach any theory that denies the story of the Divine Creation of man as taught in the Bible, and to teach instead that man has descended from a lower order of animals.

Section 2. Be it further enacted, that any teacher found guilty of the violation of this Act shall be guilty of a misdemeanor and upon conviction, shall be fined not less than One Hundred ($100.00) Dollars nor more than Five Hundred ($500.00) Dollars for each offense . . . (Grebstein, 3)

Document 2: Governor Austin Peay's special message to Tennessee legislature, March 21, 1925 (extracts)

After a careful examination I can find nothing of consequence in the books now being taught in our schools with which the bill will interfere in the slightest manner. Therefore, it will not put our teachers in any jeopardy (legal danger). Probably the law will never be applied. It may not be sufficiently definite to permit of any specific application or enforcement. Nobody believes that it is going to be an active statute . . . (quoted in Ginger, 7)

Document 3: Excerpts from Genesis, chapter one

In the beginning God created the heaven and the earth . . . (v. 1) And God said, Let us make man in our image, after our likeness: and let them have dominion over the fish of the sea, and over the fowl of the air, and over the cattle, and over all the earth, and over every creeping thing that creepeth upon the earth. (v. 26)

So God created man in his own image, in the image of God created he him; male and female created he them. (v. 27).

And God saw every thing that he had made, and, behold, it was very good. And the evening and the morning were the sixth day. (v. 31)

And on the seventh day God ended his work which he had made; and he rested on the seventh day from all his work which he had made. (Chapter 2, verse 2)
Document 4: Excerpts from George W. Hunter, A Civic Biology

The Doctrine of Evolution. We have now learned that animal forms may be arranged so as to begin with very simple one-celled forms and culminate with a group which contains man himself. This arrangement is called the evolutionary series. Evolution means change, and these groups are believed by scientists to represent stages in complexity of development of life on the earth. Geology teaches that millions of years ago, life upon the earth was very simple, and that gradually more and more complex forms of life appeared, as the rocks formed late in time show the most highly developed forms of animal life. The great English scientist Charles Darwin, from this and other evidence, explained the theory of evolution. This is the belief that simple forms of life on the earth slowly and gradually gave rise to those more complex and that thus ultimately the most complex forms came into existence. (page 194 of text)

Man's Place in Nature:

If we attempt to classify man, we see at once he must be placed with the vertebrate animals because of his possession of a vertebral column. Evidently, too, he is a mammal, because the young are nourished by milk secreted by the mother and because his body has at least a partial covering of hair . . . We must place him with the apelike mammals, because of these numerous points of structural likeness. The groups of mammals which includes the monkeys, apes and man we call the “primates.” Monkeys certainly seem to have many of the mental attributes of man . . . (and therefore) the monkey justifies his inclusion with man in a separate mental genus.” (page 195 of text) (Grebstein, 28)

Document 5: Dayton, Tennessee, Friday, July 10, 1925

State of Tennessee v. John Thomas Scopes
Nos. 5231, 5232
In the Circuit Court of Rhea County, Tennessee
Hon. J. T. Raulston, Judge

Counsel for the State
A.T. Stewart, Attorney General
William J. Bryan
William J. Bryan, Jr.
B. G. McKenzie
J. G. McKenzie
H. E. Hicks
W. C. Haggard

Counsel for the Defendant
John R. Neal
Clarence Darrow
Dudley Field Malone
Arthur G. Hays
W. O. Thompson
First Day

THE COURT: The court will come to order. The Reverend Cartwright will please open court with prayer.

THE REV. CARTWRIGHT: We beseech Thee, our Heavenly Father, that Thou will grant unto every individual that share of wisdom that will enable them to go out from this session of the court, with the consciousness of having under God and grace done the very best thing possible, and the wisest thing possible . . . Hear us in our prayers, our Father, this morning, for the cause of truth and righteousness . . . that the affairs of church and state may be so administered that God may beget unto Himself the greatest degree of honor and glory.

THE COURT: Seat everyone you can, Mr. Sheriff, and those that can’t get seats, let them stand around the wall.

THE COURT: Mr. Attorney General, come right up here, please. Let me have my docket, Mr. Clerk.

9:22 A.M.—Mr. Attorney General I am calling the case of the State v. John Thomas Scopes . . .

THE ATTORNEY GENERAL: If the Court please, in this case we think that it is proper that a new indictment be returned.

THE COURT: Do you want a jury empaneled?

THE ATTORNEY GENERAL: Yes, sir, and a new indictment.

THE COURT: Yes, sir.

THE ATTORNEY GENERAL: This indictment has been returned by agreement on both sides, but both sides are anxious that the record be kept straight and regular, and that no technical objection may be made in the appellate courts.

THE COURT: Very well . . .

THE COURT: Now let’s proceed to draw the jury, gentlemen . . .

(Grebstein, 32, 33)

Document 6: The Judge’s Charge to the Grand Jury

Gentlemen of the grand jury . . . the statute which it is alleged that John T. Scopes violated, is Chapter 27 of the acts of 1925 which makes it unlawful to
teach...any theory that denies the story of divine creation of man as taught in the Bible and instead thereof that man descended from a lower order of animals. (the judge reads Section 1 of the Act)

(the judge reads first chapter of Genesis)

Therefore, the vital question now involved for your consideration is, has the statute been violated by the said John T. Scopes?...

If you find the statute has been thus violated, you should indict the guilty person...

You will bear in mind that in this investigation you are not interested to inquire into the policy or wisdom of this legislation...

The policy and wisdom of any particular legislation addresses itself to the legislative branch of government, provided the proposed legislation is within constitutional limits.

Our constitution imposes upon the judicial branch the interpretation of statutes and upon the executive branch the enforcement of the law...

You may proceed with your investigation. (Grebstein, 34)

Document 7: Darrow Challenges a Jury Member

After the prospective jury member is questioned by the judge and the Attorney General for approval, the Defense is allowed to determine whether or not the person is suitable.

Questions by Mr. Darrow:

Q: What is your business?
A: I am a minister.

Q: Whereabouts?
A: I live in the second district of Rhea County, twenty miles north.

Q: Ever preach on evolution?
A: I don't think so, definitely; that is, on evolution alone.

Q: Did you ever preach on evolution?
A: Yes. I haven't as a subject; just taken that up; in connection with other subjects. I have referred to it in discussing it.

Q: Against it or for it?
A: I am strictly for the Bible.

Q: I am talking about evolution, I am not talking about the Bible. Did you preach for or against evolution?
A: Is that a fair question, judge?

THE COURT: Yes, answer the question.

A: Well, I preached against it, of course! (Applause)

THE COURT: Let’s have order.

MR. DARROW: Your honor, I am going to ask to have anybody excluded that applauds.

THE COURT: Yes, if you repeat that, ladies and gentlemen, you will be excluded. We cannot have applause. If you have feelings in this case you must not express them in the courtroom. If you do, I will have to exclude you.

Q: Have you formed a strong conviction against evolution?

A: Well, I have.

Q: You think you would be a fair juror in this case?

A: Well, I can take the law and the evidence in the case, I think, and try a man right . . .

Q: Have you heard of Mr. Scopes?

A: Yes, Sir; yes.

Q: You have heard that he is an evolutionist, haven’t you?

A: Yes, sir, I have heard that . . .

Q: You now have the opinion that evolution is contrary to the Bible and that my client has been teaching evolution; as you stand there now, that is your opinion?

A: Sure it is.

Q: You could change it if you heard evidence enough to change it on?

A: Yes, sir.

Q: Otherwise you couldn’t?

A: I have no right to; I don’t think.

MR. DARROW: I challenge for cause.

THE COURT: Well, I want every juror to start in with an open mind. I will excuse you, Mr. Massingill.

After a total of seven additional challenges by Darrow, the Court, and the prosecution, the jury was completed. (Grebstein, 40-42)
Document 8: The Court Questions Darrow

B: Do you believe that the Bible is the revealed will of God, inspired and trustworthy?

D: I think there is much of value in the Bible, but I do not believe it is written or inspired by God. I believe it should be taken as every other book, and that the portions in it that are sublime, like such portions of every other great book, might be called inspired . . .

B: Do you believe in the miracles recorded in the Old and New Testaments?

D: I do not believe in miracles. I believe the universe acts and always has acted according to immutable law, and that whatever may be back of the universe, it has never violated these laws.

B: Do you believe in the immortality of the soul?

D: I have been searching for proof of this all my life with the same desire to find it that is incident to every living thing, and I have never found any evidence on the subject. (Grebstein, 132-133)

Document 9: Quotation Sheet—Evolution and the Bible

As you read the following statements, ask yourself which of the following might agree with each one: John Scopes, William J. Bryan, Clarence Darrow, Judge Raulston.

1. “Evolution has no purpose; man must supply this for himself.”
2. “The Butler Act rested on the belief that truth can be determined by taking a vote.”
3. “Parents should not be deprived by Government of the right to direct the lives and education of their own children.”
4. “If I lose faith in Genesis, I’m afraid I’ll lose faith in the rest of the Bible, and if I want to commit larceny I’ll say I don’t believe in the part of the Bible that says ‘thou shalt not steal.’ The same thing applies to murder.”
5. “In a democracy issues of policy must be resolved by the elective process, not by appointive judges.”
6. “In the history of the world there has been nobody who has dealt scientifically with all questions.”
7. “Morality depends on religion. Government cannot be indifferent to religion.”
8. “Apart from human purposes, no purpose exists.”
9. “Human life is nothing without purpose. Read the Bible to determine God’s purpose for you.”
10. “Man has no real freedom of will; he is a machine; a product of heredity and environment.”

Annotated Bibliography

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John Scopes’ recollections forty years after the trial. Includes several Appendices of Affidavits read into the Dayton Court record in 1925. Illustrated.
Weinberg, Arthur, ed. *Attorney For the Damned*. New York: Simon and Schuster, 1957. A summary of the many famous cases Clarence Darrow was participant in; a good introduction to the Scopes trial to set the mood.

**Articles**


10
The History of Flight and Some Mathematical Application

Hermine Smikle

1. INTRODUCTION

Today's mathematics curricula and education goals should reflect the importance of mathematical literacy. Therefore this unit will attempt to reflect some of these new directions both in the content and the method of teaching.

The new direction can be summarized in the following statements:¹

Students should learn the value of mathematics.

To reduce math anxiety, students should become more confident in their abilities to do the subject.

Students should become more confident and develop skills as mathematic problem solvers.

Students learn to communicate and reason mathematically.

Students should be able to think of diverse ways to solve a problem.

The mathematics curriculum should also reflect the mathematical needs of the next decade. Today's students will be working with tools and in an environment that will need an understanding of more complex thinking skills. Teachers and curriculum planners must understand and anticipate the changing needs of industries and the society.

Henry Pollak² (1987) summarized the mathematical needs and expectations for employers in the industrial sector of the future.

1. The ability to set up problems with the appropriate operations.
2. Knowledge of a variety of techniques to approach and work on problems.
3. Understanding the underlying mathematical features of a problem
4. The ability to work with others on a problem.
5. The ability to see the applicability of mathematical ideas to common and complex problems.
6. Preparation for open problem situation since most real life problems are not well formulated.
7. The belief in the utility and the value of mathematics.

II. RATIONALE AND GENERAL OBJECTIVES OF THE UNIT

The study of aerodynamics has assisted in providing the world with the most efficient mode of transportation. As a result of these achievements a large industry has arisen that needs to be kept supplied with qualified personnel both skilled and unskilled.

Most of the high school curriculum today has placed great emphasis on the four-year-college-bound student; but there is a growing demand for workers who are literate in mathematics in all sectors of the society.

This unit in aerodynamics will attempt to find the mathematical concepts that are essential to flight with special interest in the concepts that relate to path problems.

The development of this unit will be justified by the emphasis placed on making mathematics relevant, practical and meaningful to the student, thus providing them with answers to “Why do I need to do this?” or “Where in the real world would I ever use this?”

The theme behind the development of this unit is to present mathematical concepts that are not usually taught in the curriculum of students that are labeled low achievers, and to present these topics using flight as the major focus.

It has been a challenge to teach students in the lower mathematics classes. These students have been accustomed to failing the traditional topics such as fractions and decimals; and in high school they find mathematics difficult, boring and impractical. They have been kept out of the mainstream of mathematics because of their inability to pass the proficiency tests.

In my quest to present these students with mathematics concepts that would otherwise be outside their curriculum, I have attempted to present these topics differently by relating them directly to flight, thus forging a connection between the historical concepts and some of the mathematics that can be applied to it.

The teaching approach would be to expose these students to the readings of the historical development. This could be done as a class project or individual students could do research on different areas. The mathematical concepts could be introduced from the viewpoint of students planning a flight in an aircraft then considering the logistics of the flight. Navigation, and spherical geometry could be applied here with the theme: “Planning a Journey.”
The introduction of graph theory could be introduced as a tool to solving problems that relate to the activities that present themselves during the flight: loading and unloading the aircraft; the job activities of the air hostess; even the time line of activities for passengers. Students could brainstorm and develop their own problems.

I share the beliefs presented in the Mathematics Standards prepared by the N.T.C.M., that mathematics should be made relevant, that its application should be shown across subject areas, and that all students can be successful in mathematics.

**General Objectives of the Unit**

The unit will be designed to help students:

a) To acquire knowledge about the historical development of the industry.  
b) To develop the ability to apply their knowledge in math to the task of problem solving.  
c) To apply specific graphing skills to solving problems.  
d) To use Graph Theory to solve problems related to paths.  
c) Introduce students to Spherical Geometry as a link between Geography and Geometry.

**III. HISTORICAL OVERVIEW OF THE DEVELOPMENT OF AIRCRAFT**

**A. Developments before the Wright Brothers**

Men had always wondered why it was impossible for them to attain the art of flying. They questioned the ability of birds to fly. As a result of their fascination for flying, stories of man's ability to fly have been embedded in the Greek myths of Dacdalus and his son, Icarus.

The stories were centered around his escape from the island of Crete where he was imprisoned. They described how they fastened wings with wax to their bodies and flew through the air; Icarus flew too near the sun, the wax melted and he fell to his death in the sea.

Man's idea about flying was thus centered on the imitation of birds; as a result various medieval people fastened wings to their bodies and tried to fly. Many fell to their most unfortunate fates.
Finally men gave up the idea of strapping a pair of wings to their bodies to enable them to fly. It was replaced by the concept of wings which were flapped up and down by some mechanical mechanism. Powered by some type of human arm, leg or some other body movement. These were the ornithopters.

Leonardo da Vinci designed a number of these. Above is a sketch of his ornithopter.⁵

Ornithopters did not accomplish any successful flight; therefore they made no contribution to the advancement of flight.

It was not until November 21, 1783 that human efforts to fly were accomplished. This was done when the balloon flown by the Marquis d’Ariandes went up in the air and flew 5 miles to Paris.
This balloon was inflated and buoyed up by hot air coming from a fire beneath it.

The Montgolfier brothers thought of the lifting power of hot air and its ability to lift a person from the earth. They experimented with different materials (bags made with linen in which hot air was trapped). They had several public demonstrations and finally the flight of November 1783.

The flight served its purpose by triggering the public's interest in the ability of man to fly.

It was not until the advent of Sir George Cayley (1773-1857) that the concept to include a fixed wing for generating lift and a separate mechanism for propulsion was originated. He envisioned paddles and a horizontal and vertical tail for stability. These ideas were inscribed on a silver disc.

With these ideas Cayley introduced the concept that lift was different from propulsion and therefore set the stage for the developments that took place later.

He devoted a life of study to aerodynamics. In 1804 he built a whirling arm apparatus for testing airfoils; this was a lifting surface mounted on the end of a long rod, which was rotated at some speed to generate a flow of air over the airfoils. This is analogous to the wind tunnels today. It was an important development because it allowed the measurement of aerodynamic forces and the center of pressure on the lifting surface. These developments can be considered the first step in aerodynamic testing.

In 1804 he designed, built and flew a small model glider.
He documented his developments in a paper entitled “On Aerial Navigation.” This was published in 1809. In 1849 he built and tested a full size airplane by which a ten year old boy was carried along and lifted several meters from the ground.

He had the concept of stacking several wings on top of each other (biplanes and triplanes); he had the fear that a single wing would fail. This idea was carried down into the twentieth century. It was only in the 1930s that the monoplane became the dominant airplane configuration.

It was sometime in 1853 that Cayley built and flew the world’s first human-carrying glider. The configuration is unknown; it could have been a triplane and looked like the boy carrier.

After Cayley’s death in 1857, not many inventions took place for the next fifty years.

Other landmark discoveries

William Samuel Henson (1812-1888): he published a design for a fixed wing airplane powered by a steam engine driving two propellers. This was called the aerial steam carriage.

This design was a direct result of Cayley’s ideas and research in aeronautics.

John Stringfellow, a friend of Henson, built several small steam engines and attempted to power some model monoplanes off the ground. He was not very successful. His most recognized work appeared in the form of a steam powered triplane. His triplane was the main bridge between Cayley’s work and modern aeronautics.

Felix Du Temple (1857-1858) flew the first successful powered model airplane. It was a monoplane; it had wings and was powered by clockwork.
The second airplane (1874) had the first powered takeoff by a piloted full sized airplane. It had wings and was powered by hot air engine. The machine was launched down an inclined plane.

Alexander F. Mozhaiski was a Russian; in July 1884 he designed an aerial steam carriage. It was launched down a ski ramp and flew for a few seconds.

These attempts did not satisfy the criteria of sustained flight, but could be considered assisted powered takeoffs.

B. The age of the glider

Otto Lilienthal was one of the giants in aeronautical engineering. He designed and flew the first successful controlled glider in history.

Because of his interest in flight, he studied the structure and types of birds’ wings and applied this information to the design of mechanical flight.

In 1889 and again in 1890, he designed and flew gliders, but both were unsuccessful. In 1891 he had his first successful glider flight from a hill in Germany.

The general configuration of this monoplane glider was one of a birdlike platform of the wing. He used chambered airfoil shape on the wing and used vertical and horizontal tail planes in the back for stability. These machines are the forerunners of the hanggliders today. Flight control was exercised by shifting one’s center of gravity.

Lilienthal can be classified as an airman in contrast to those who were called chauffeurs. The distinction was drawn between those who were concerned with thrust and lift, and the airmen who were concerned with flight in the air.

Lilienthal made about 2000 successful glider flights. His aerodynamic data were widely read. He died during a glider flight in Germany on August 9, 1896.

Percy Pilcher studied with Lilienthal and under his guidance made several glides. He could be classified as an airman; he understood the need for understanding natural flight, before engaging in machine powered flights. He built a machine called the Hawk in 1896. It was powered by a 4 hp engine weighing 40 lbs. He died while flying this machine.

C. Aeronautics in the United States

Most of the advances that had been made in heavier than air flying machines were made in Britain and in Europe. These developments were taking place during the
time when the United States was more concerned with land expansion and the consolidation of a new government; aeronautical developments had no impact.

This interest in flying was taken by Octave Chanute (1832-1910). He collected and studied all the aeronautical information available. He later published his book *Progress in Flying Machines*. In his book he summarized all the important progress in aviation. He could be considered the first aviation historian.

He designed hang gliders and produced a biplane glider. He bridged the gap between Stringfellow's triplane and the successful powered flights of 1903.

Samuel Pierpont Langley (1834-1906) designed and built a series of powered aircrafts, which resulted in piloted flights in 1903.

Langley followed in the tradition of Cayley and therefore built a large whirling arm, powered by a steam engine. This he used to make tests on steam airfoils.

In 1896 Langley was successful when one of powered models made a free flight of 3300 ft and later another flew over 3/4 mile. These “Aerodromes,” as he called them, were tandem winged vehicles, driven by two propellers between the wings that were powered by a 1 hp steam engine.

After studying Stringfellow's work he set out to design a better engine. In 1898, the war department commissioned him to build a machine for passengers. He decided that a gasoline fueled engine would be best for use on an aircraft. A 52.4 hp engine resulted from his efforts. He used a 3.2 hp gasoline fueled engine to have a successful flight with a 1/4 scale model. With this encouragement he started to design a full scale airplane. He mounted this aircraft on a catapult in order to provide an assisted take off; this contraption was placed on top of a houseboat on the Potomac River.

On October of 1903, with his companion Charles Manley at the controls, he made his first attempt at flying. The aircraft fell into the water soon after launch. They tried again on December 8, 1903 but had the same consequences.

Langley abandoned his attempt at human flight after his failures and the criticisms from the press.

Critics of Langley classified him as a chauffeur because he had not paid much attention to the aspect of flight control; he did, however, leave a legacy by the contributions he made to aeronautics.

**D. The Wright Brothers**

The Wright brothers drew on the rich heritage in aeronautical experiences left them by their predecessors. They became interested in aviation after the flight of Otto Lilienthal in 1896. They took up the study of birds as a guide to mechan-
tical flight; from their study they concluded that birds regain their lateral balance when partly overturned by a gust of wind. This emerged as the single most important development in aviation history, the use of wings’ twist to control airplane in rolling motion. They coined the phrase “wing warping.”

They read all the available literature on the advancements in aeronautics, then set out to experiment with wing warping. To test this concept they built a biplane with a wing span of 5 ft. that was controlled from the ground with strings. This concept worked.

Encouraged, the Wright brothers decided to test this concept, but not before gaining experience as “airmen.” They made their first 17 ft wing span by September 1900 and flew it from Kitty Hawk on October of that year.

With this success they proceeded to build a second glider from their new headquarters at Kill Devil Hills 4 miles to the south of Kitty Hawk; it was tested in July and August of 1901. This new glider was larger than the previous one. It had a wing span of 22 ft.

The Wrights were very suspicious of the existing data from the literature, especially those generated by Lilienthal and Langley. They built their own wind tunnel and did their own investigations. From these researches they built the number three glider. This was flown in December 1902 and provided much information on the impact of wind tunnels.

During 1902, they made more than 1000 perfect flights and set a distance record of 26 seconds. The brothers had become experienced and skillful pilots, and with all the theoretical and practical problems solved, they felt that they could construct a machine whose stability and control in the air depended on the pilot’s skill. The only difficulty was to find an existing engine capable of powering the aircraft. They could not find such an engine; therefore they designed and built their own. It was 12 hp, water cooled, and weighed only 200 lbs. They also built their own propeller; thus they produced their first powered machine the “Flyer” in the summer of 1903.

They returned to their camp to find it in disarray. They repaired the number 3 glider and practiced. Finally overcoming all setbacks (weather, mechanical breakdowns), they were ready to test the Flyer. It was a biplane of 40 ft with a wing area of 510 square feet and used a double rudder behind the wings and a double elevator in front of the wings.

With conditions favorable, they called five witnesses, and with a camera set up for pictures the Flyer made its first historic flight. (Orville was at the controls.)

They did not stop with Flyer 1. In May 1904 they flew their second powered machine, Flyer 2. They made improvements with a smaller wing camber. By
1905 Flyer 3 was ready. It was described as the world's first practical powered aeroplane, justified by the sturdiness of its structure. With their combined contribution, research and inventions, the world was on the threshold of a new form of vehicle for public transportation.

E. The emergence of the aircraft as a valuable means of transportation

During 1909 the aeroplane had become accepted as the world's new practical vehicle. Louis Blériot's crossing of the Channel on July 25, and the first air meeting at Rheims in August were significant signs.

With the Wrights' achievements and techniques to follow, European airmen came into their own; so during the first half of the 1900s there was a growing number of aviators, designers and amateurs, and the forms of their aircraft began to multiply. The dominant types of aircraft became more efficient and reliable. The message of powered flying began spreading over the world and the beginnings of an aircraft industry, as well as governments' concerns with aviation, became evident.

There were some difficulties to be overcome to make the aeroplane more efficient.

1. The development of an engine with enough horse power to lift an aircraft off the ground. This was solved with the development of gasoline fueled internal combustion engines (the Wright brothers were pioneers in this area). The automobile industry then led the development of new engines.

2. The development and the search for aeroplanes that could fly faster and higher. This problem was solved partly by the introduction of competitions; this prompted and advanced development of high speed aircraft. One notable competition was the Schneider race.

Military aviation became a serious concern of leading European nations. As a result military and naval flying schools were established.

When the First World War was declared, the aeroplane's duties were as aerial intelligence agents or scouts for visual and photographic reconnaissance. During the war years the aircraft industry in Europe and the United States expanded from a handful of machines in 1914 to 3300 in use by 1918. It also provided many jobs, from a few hundred in 1914 to nearly 350,000 workers in 1918.

After the war there was more technical progress made and the acceptance of the importance of flying was extended in the public's mind, and air transport became a means of public transportation. As Cayley predicted, "We shall be able
to transport ourselves and our families and their goods and chattels, more securely by air than by water.”

With the far reaching developments of combat aircraft, and the various equipment for flying and communicating, comparable developments were taking place in the aircraft for civil transport.

After the war years, the non-military sphere of flying saw the most dramatic developments. In 1919, the first air transport with scheduled airlines started in Europe. The first civil airline for passengers began in Germany February 8, 1919, with service between Berlin, Leipzig and Vienna.

The machines used in France, England and America as transport planes were wartime bombers adapted to passenger planes.

One important landmark in the air transport and private flying was the solo flight direct from New York to Paris on May 20-21, 1927. It helped to transform the entire travel industry and made the public more air-minded.

It was in the United States that the first modern type airliner was the Boeing 247, flown in February 1933. The second was Douglas DC-1 flown in July 1933.

These are a few of the airliners that emerged as a result of the developments in aerodynamics and the demand for passenger planes.

With the advent of the Second World War, there were enormous developments in aviation and in aeroplane engines and all the types of equipment used in flying. This period saw the jet propelled aeroplane and the production of helicopters and long ranged rockets. After the war the industry turned its attention to transport production.

The leader in developing light and medium transports was the United States. Aircraft were developed that set the style for modern heavy transports with the Douglas Dakota (DC-3). This aircraft monopolized the traffic on the world’s long haul airlines after the war.

Following is a list of the aircraft that were developed and their passenger capabilities.

1. Douglas Dakota (DC-3), USA
2. Junkers Ja 52, Germany
3. Douglas DC-4 Skymaster (Military C-54): February 1942. It had a crew of six and 42 passengers.
5. Lockheed 049 (C-69): Jan 1943, carried 52 passengers.

The preceding pages do not cover all the developments of the types of aircraft that came into existence, but they do show that the stage was set for the use of
the aircraft as a public transport system. The need was met as a result of the inventions that arose, so that the aircraft could be viable in the war years. After that, technology was directed towards passenger travel.

The years after the wars also saw the research in aerodynamics directed to rocketry and the aerospace industry.

From the developments described in the previous pages, one can point to many fruitful instances of applied mathematics. The following sections will attempt to present some of the mathematical topics that can be brought to bear on the history of flight.

IV. THE MATHEMATICAL APPLICATION

A. Geometry

1) Introduction to Vectors to Represent a Journey

If a displacement has taken place, this movement can be written as a displacement vector.

The position of the plane in the picture relative to the airport can be described as 5 miles, bearing 053 degrees.

If the same picture is drawn on graph paper:

The position of the plane could be described as 4 miles east and 3 miles north. Instead of saying 4 miles east and 3 miles north we could write (4/3). This
is a vector representation of the position of the plane. The distance to the east is written first followed by the distance to the north.

If the plane moves from position S to position Q and the movement is 2 miles east and 6 miles north the total journey can be represented as a sum \((4/3) + (2/6) = (6/9)\). Vectors can be added by adding the top components 4 + 2 and the bottom components 3 + 6.

2) Angles and Bearings

Bearings are measured from the north line, the line or axis about which the earth rotates. It cuts the surface of the earth at what are called the north and south poles. The pole star is almost on this line and so appears to be fixed in the heavens, while other stars seem to rotate about the axis. The pole star gives a fixed direction from which navigators used to set their course. Today the magnetic compass, which points in approximately the same direction, is used to set a course.

To set the bearing

i) always start from the north line and
ii) always measure the angle clockwise.

The following example will be used to demonstrate how to draw a model of a journey.

A pilot on an aircraft made a two stage journey.

Stage A: 500 miles, bearing 060 degrees
Stage B: 300 miles, bearing 150 degrees

1st step: Draw the north line (NA), and measure the 060 degrees angle clockwise from the north line. Draw a line to represent 500 miles from the point A to B. This represents the first leg of the journey.

2nd step: At point B draw another north line, measure the angle of 150 degrees, and draw the length 300 miles.
If the pilot had flown from A to C, we could measure the bearing of C from A and measure the length of the line segment AC. The stages of this journey can also be written as a displacement vector: (500, 060 degrees) followed by (300, 150 degrees).

3) Navigation and Spherical Geometry

The following topic is being introduced with the intent of providing an enrichment topic for students in the higher mathematics courses, since some experience with trigonometry, logarithms and rotational symmetry would be required.

There are several methods of navigation: Pilotage is the method of flying an aircraft from one point to another by the observation of landmarks either already known or recognized from a map. This method has limitations, because if the flight is over poorly mapped country, over large bodies of water, or at night when visibility is poor, it is difficult to use the landmarks. This method is most efficient when used with other forms of navigation.

The method Dead Reckoning is the basic method of navigation. It uses known or established factors such as wind direction, wind velocity, and air speed to compute a position from a known position. Lindbergh used Dead Reckoning on his flight from New York to Paris.

Radio Navigation is method of directing an aircraft from one point to another by radio waves. Its major feature is that one does not wait to see the ground to make approaches and landings.

Celestial Navigation is the oldest method of navigation. This is the determination of an aircraft by the observation of the celestial bodies to determine position.
Using a globe is the only accurate means of representing the spherical surface of the earth. To make a mathematical model of the earth choose the diameter NS passing through the north and south poles as axis of rotation. If O is the midpoint of NS, and OQ is perpendicular to NS then the locus of Q is the equator.

To make a two-dimensional diagram of a sphere, the equator and the parallels of latitude and the meridians are drawn.

4) Latitude and Longitude. The coordinates used to describe points on the Earth's surface.

The position of a point A on the surface can be determined by stating:

a) Which circular section perpendicular to NS contains A.
b) Which position of the semi-circle rotating about NS contains A.

These pieces of information are given by specifying

i) the latitude and
ii) the longitude of A.

Figure III shows the equator and the circles, or parallels of latitude 60 degrees N and 50 degrees S. The range of latitude is from 0 degrees to 90 degrees north or south of the equator.

Figure IV shows the equator, the Greenwich meridian NGS and the semicircles, or meridian of longitude 40 degrees W and 20 degrees E. The range of longitude is from 0 degrees to 180 degrees East and West of Greenwich.
Figure V shows point A with latitude $t$ degrees N, and longitude $g$ degrees W.

Figure VI shows the point P with latitude 60 degrees N and longitude 50 degrees W. Figure VII shows the point Q with latitude 30 degrees S and longitude 50 degrees E.

**The solution of right spherical triangles**

A spherical angle is formed by intersecting arcs of two great circles. The three important properties of spherical triangles are:

a) the sum of the lengths of any two sides exceeds the length of the third side;
b) the sum of the lengths of the three sides is less than 360 degrees;
c) the sum of the angles is greater than 180 degrees but less than 540 degrees.

To find the great circle distance between two points A and B, the triangle of reference is constructed as follows:

i) The great circle joining A and B form one side of the triangle;
ii) The meridians through both A and B form the other two sides.
Two such triangles are formed and either can be used to obtain the great circle distance from A to B. Example: Suppose A has latitude 60 degrees N, longitude 55 degrees E, and B has latitude 60 degrees N, longitude 13 degrees W. The length of arc AB can be calculated as follows.

\[
\text{Length of arc} = \frac{\text{circumference of latitude circle}}{360^\circ} \times \frac{\text{size of } \angle ACB}{360^\circ}
\]

\[
\text{arc } AB = \angle ACB \times 2R \times (R \cos t)
\]

° The radius of a circle of latitude t degrees = R \cos t degrees where R the radius of the earth is 6400 km.

\[
- \frac{68 \times 2 \times 3.14 \times 6400 \times \cos 60^\circ}{360^\circ}
- 3800 \text{ km.}
\]

If a plane or ship follows a great circle path, its course is the angle the path makes with the meridian of the ship and is measured from north through east to the path of the ship.

B. An Introduction to Graph Theory

The concept of drawing a graph to represent information has been used extensively in mathematics. These ideas have been used to plot the routes of the mailman, and of various delivery companies. These ideas are also extended to the airline industry. They have been used in determining routes between cities, and in providing a time line for doing various activities that enable the efficient disembarkation and unloading of baggage on an aircraft.

Just as model aircraft are used to represent the real thing, models in this section will be used as a representation of something else. The model or graph will be used to give us an idea of what reality is.

A graph is a finite set of points, called vertices, together with a finite set of curved or straight connecting lines called edges, each of which joins a pair of vertices. These vertices and edges satisfy the condition that no edge begins or ends at the same vertex. Graphs without edges are called null graphs.
The figure in c) is not a graph because it violates the condition that no end may join a vertex to itself. When a graph has two or more different edges joining the same pair of vertices, these edges are called multiple edges.

The edge of a graph can be identified by using a letter to name it, and the vertices (endpoints) can also be named. The edge E can be named \((X_1, X_2)\).

Graphs are important tools in representing a vast number of real world problems. Graphs that are used to represent the layout of streets are called street networks. In this instance the edges of the graph can have a direction indicated by arrow. These graphs are called digraphs. A digraph is a finite, non-empty set of points called vertices, together with some directed edges joining these points. These edges are subjected to one restriction. The initial and terminal vertices of a directed edge may not be the same.
1) Graphs and Matrices: Matrices from Drawings

Matrices are presented as a means of storing information in which the position of the information is very important. The direct route matrix is used since it enables us to predict properties of more complicated networks without reproducing them.

The figure shows a network of roads:

A direct route is the journey which does not pass through another endpoint.

One way of describing a direct route linking endpoints is to use an arrow diagram.

Another way of describing this is to use a table where zero means no direct route, 1 means 1 direct route, 2 means two direct routes, etc.

<table>
<thead>
<tr>
<th></th>
<th>$X_1$</th>
<th>$X_2$</th>
<th>$X_3$</th>
<th>$X_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<td>1</td>
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<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

The rectangular array of numbers from the table can be represented in a matrix:

$$
\begin{bmatrix}
0 & 2 & 1 & 1 \\
2 & 0 & 1 & 0 \\
1 & 1 & 0 & 0 \\
1 & 0 & 0 & 0
\end{bmatrix}
$$

Instead of talking about endpoints or vertices and edges these ideas can be applied to real life situations. The vertices or endpoints can be referred to as towns or cities and the edges can be called routes or roads.
The diagram shows a network of roads between several towns with their direct routes.

One way of showing the direct routes linking the towns is to draw the arrow diagram.

\[
\begin{array}{cccccc}
\text{C} & \text{L} & \text{O} & \text{P} & \text{T} \\
\hline
\text{C} & 0 & 1 & 0 & 1 & 1 \\
\text{L} & 1 & 0 & 0 & 1 & 0 \\
\text{O} & 0 & 1 & 0 & 0 & 1 \\
\text{P} & 1 & 0 & 0 & 0 & 1 \\
\text{T} & 1 & 1 & 1 & 1 & 0 \\
\end{array}
\]

\[T_0\]

\textit{Directed Maps}: A map of a one-way system is called a directed map because arrows are placed on the roads to show in which directions to go.

\[
\begin{array}{ccccccc}
\text{A} & \text{B} & \text{C} & \text{D} & \text{E} \\
\hline
\text{A} & 0 & 1 & 0 & 1 & 0 \\
\text{B} & 1 & 0 & 1 & 0 & 0 \\
\text{C} & 0 & 0 & 0 & 2 & 0 \\
\text{D} & 1 & 1 & 1 & 0 & 0 \\
\end{array}
\]
The matrix of a directed map is different from the matrix of an undirected map since it is not symmetrical and it is also possible to have odd elements on the leading diagonals.

2) Finding the Shortest Path

A graph or network is defined by two sets of symbols, *nodes* and *arcs*. Nodes are the set of points or vertices, arcs consists of an ordered pair of vertices and represents a possible direction of motion that may occur between vertices.

\[
V = \{1,2,3,4\} \\
A = \{ (1,2), (2,3) \}
\]

Arcs can be considered as one-way roads. For shortest path problems it will be assumed that each arc in the network has a length associated with it. The problem of finding the shortest path is the minimum length from one node to any other node in the network.

*Dijkstra's Algorithm:*\(^{10}\) This algorithm for finding the shortest path between a pair of nodes requires that all the arcs in the network have non-negative arc length.

The algorithm uses this method:

1. Designate node one as the starting point.
2. Find the node closest to node one.
3. Find the second closest node to node one.
4. Find the third closest node to node one.
5. Continue until all the paths are used.

Let us use this method in the following example.
The distances can be summarized in a table:

<table>
<thead>
<tr>
<th>PATH</th>
<th>LENGTH OF PATH</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Determination of the second closest node to node 1.</td>
<td></td>
</tr>
<tr>
<td>The arc (1,2)</td>
<td>4</td>
</tr>
<tr>
<td>The shortest path from node 1</td>
<td></td>
</tr>
<tr>
<td>to node 3 + arc (3,5)</td>
<td>3 + 3 = 6</td>
</tr>
<tr>
<td>2. Determination of the third closest node to node 1</td>
<td></td>
</tr>
<tr>
<td>The shortest path from 1 to 3</td>
<td>3 + 3 = 6</td>
</tr>
<tr>
<td>+ arc (3,5)</td>
<td></td>
</tr>
<tr>
<td>Shortest path from 1 to 2</td>
<td></td>
</tr>
<tr>
<td>+ arc (2,5)</td>
<td>4 + 2 = 6</td>
</tr>
<tr>
<td>Shortest path from 1 to 2</td>
<td></td>
</tr>
<tr>
<td>+ arc (2,5)</td>
<td>4 + 3 = 7</td>
</tr>
<tr>
<td>3. Determination of the fourth closest node to node 1</td>
<td></td>
</tr>
<tr>
<td>Shortest path from 1 to 2</td>
<td>4 + 3 = 7</td>
</tr>
<tr>
<td>+ arc (2,4)</td>
<td></td>
</tr>
<tr>
<td>Shortest path from 1 to 5</td>
<td>6 + 2 = 8</td>
</tr>
<tr>
<td>+ arc (5,6)</td>
<td></td>
</tr>
<tr>
<td>4. Determination of the fifth shortest path from node 1</td>
<td></td>
</tr>
<tr>
<td>Shortest path from 1 to 4</td>
<td>7 + 2 = 9</td>
</tr>
<tr>
<td>+ arc (5,6)</td>
<td></td>
</tr>
<tr>
<td>Shortest path from 1 to 5</td>
<td>6 + 2 = 8</td>
</tr>
<tr>
<td>+ arc (5,6)</td>
<td></td>
</tr>
</tbody>
</table>

Summary of shortest path

<table>
<thead>
<tr>
<th>Nodes</th>
<th>Closest nodes to Node 1</th>
<th>Path from Node 1 to the nth closest node</th>
<th>Length of path</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>1-3</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>1-2</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>1-2-5 or 1-3-5</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>1-2-4</td>
<td>7</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>1-3-5-6 or 1-2-5-6</td>
<td>8</td>
</tr>
</tbody>
</table>

The shortest path from node 1 to node 6 is either 1-2-5-6 or 1-3-5-6; both have length 8.
The digraph can also be used to solve complicated problems. Consider this problem: We wish to minimize the time an aircraft spends at an airport. The component activities can be placed in a table:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1 Disembark passengers</td>
<td>1/2 hr.</td>
</tr>
<tr>
<td>A2 Unload baggage</td>
<td>1 hr.</td>
</tr>
<tr>
<td>A3 Clean the plane</td>
<td>1/2 hr.</td>
</tr>
<tr>
<td>A4 Take on new passengers</td>
<td>1 hr.</td>
</tr>
<tr>
<td>A5 Load new baggage</td>
<td>1 hr.</td>
</tr>
</tbody>
</table>

We could simply sum all the numbers of hours but some of these tasks can be done simultaneously and some operations are independent of others. A good way to proceed is to draw a model called "The Activity Analysis Digraph."

An Activity Analysis Digraph is constructed in the following way.

1. Represent each activity by a node A1, A2, \ldots, A_n with the time required for the activity.
2. Create two additional nodes each labeled with the number zero, one representing the job's beginning and the other the job's end.
3. Draw a directed edge from one activity to the next only if the first activity precedes the second.

Now that we have drawn a model, the problem is to determine the shortest time for the completion of the whole job. We can proceed as follows:

1. Denote time \( t \) measured from starting point B; \( t = 0 \)
2. Rephrase the problem; given an Activity Analysis Digraph for a project. What will be the shortest time at which E, the end, can be completed?
3. Add the times for all activities on the path up to but not including E (There may be more than one path from B to E).

The critical path is the path of longest time from B to E. To determine the most efficient schedule in the problem is the critical path B, A2, A4, which has length of two hours and this gives the minimum time for the whole job to be completed.

To explain, the activities A1 and A2 can both be started at time zero (passengers can disembark and luggage be taken off at the same time).

The activity A3 cannot be started until all the passengers are taken off; the activity A4 cannot be started until A3 is completed but can be made to overlap with A5; we cannot arrive at E until both A4 and A5 are completed.
V. SAMPLE LESSON PLANS

Sample Lesson Plan 1

**Topic**  Introduction to Graph Theory.

**Objectives**  Students will be able
a) to define a graph, and a null graph.
b) to differentiate between graphs, null graphs and drawings that are not graphs.
c) to identify the parts of a graph.
d) to identify a digraph.
e) to use a graph to represent a problem.

**Prerequisites**
a) Plot points
b) Draw straight lines.

**Skills and Concepts Presented**
a) Plotting and joining points
b) Organizing information.

**Developments**
1. Develop a dialogue that would show the students the importance that drawing a diagram (in this case graphs) has in solving problems.
2. Point out that graphs are considered as models and therefore can be used to represent a situation.
3. Introduce the airline problem from the content.
4. Introduce and explain each step:
   i) how to organize the information in a table.
   ii) introduce vertex or nodes and edges.
   iii) give examples of null graphs, graphs, and drawings that are not graphs
5. Formally define graphs and digraphs.
6. Present drill and practice for students to use the information discussed.
Possible Problems for Discussion
1. In the following sketches identify the vertices and the edges.

2. Identify each of the following as graphs or not a graph.

3a. Draw a complete graph with six vertices.
3b. How many edges are there?
4. Draw a null graph with eight vertices.
5. Draw a graph to show the friendship relation among four individuals.

Extension Activities
1. Have students suggest possible problems from which they can produce a graph.
2. Have students draw a digraph of friendship relation in the classroom.
3. The following are dependent statements (implications exist between them):
   a) The Wright brothers' first flight.
   b) Better aircrafts invented.
   c) More jobs provided.
   d) Standard of living improved.
   e) More people take trips on airplanes.

   Draw a digraph to show the relationship between the statements.
Sample Lesson Plan 2

**Topic** The airplane problem revisited.

**Objectives** Students will be able
a) to draw a model for the problem.
b) to identify a critical path.
c) to find a solution for the problem.

**Prerequisites**
a) to draw a graph or a digraph.

**Skills and Concepts Presented**
a) Organization of data.
b) Constructing an Activity Analysis Digraph.
c) Finding the critical path.

**Developments**
1. Review nodes, vertices and edges.
2. Review drawing graphs.
3. Re-introduce the airplane problem.
4. Organize the information in a table.
5. Discuss the reasons for a starting and ending position.
6. Introduce the method of making “The Activity Analysis Digraph.”
7. Draw a graph from the information (have students suggest possible order in which the activities can be done).
8. Introduce the words critical paths. Discuss all the possible paths.
9. Have students suggest possible answers.

**Extension Activities**
1. Have students suggest tasks that they would like to represent using an activity digraph.
2. Draw an activity digraph for a person getting ready to go on vacation.
3. Draw an activity digraph for the activities of the air hostesses during the flight.
4. A group of girls decided to cook lunch for some friends. The activities were:
A. Clean house 30 mins  
B. Decide on menu 15 mins  
C. Purchase food 60 mins  
D. Cook food 50 mins  
E. Set table 10 mins  
F. Place cooked food on table 5 mins

Draw an activity analysis digraph for this job. Find the shortest possible time that these tasks will take.

Sample Lesson Plan 3

**Topic**  Vectors as a means of representing a journey.

**Objectives**  Students will be able  
  a) to read a network.  
  b) to identify direct routes.  
  c) to identify direct routes in an arrow diagram.  
  d) to use a table and a matrix to show direct routes.

**Prerequisites**  
  a) The ability to read and draw graph and digraphs.

**Skills and Concepts Presented**  
  a) Drawing and reading networks.  
  b) Identifying direct routes.  
  c) Drawing arrow diagrams.  
  d) Representing direct routes on a table.  
  e) Writing simple matrices.

**Developments**  
1. Review drawing graphs.  
2. Discussion of the network of streets in their towns.  
3. Use a map of flights between cities to show a network (ads in newspapers showing connections).  
4. Use a simple network to show key points  
   a) towns represented by a dot (vertices)  
   b) routes represented by edges.
5. Define direct routes. Have students identify direct routes on map shown.
6. Introduce the arrow diagrams as one way of representing direct routes.
7. Introduce the table as another way of representing routes.
8. Introduce the matrix as a short cut to writing the routes.
9. Discuss and define the matrix.
10. Discussion and Questions from the matrix.
   a) Deduce important features from the matrix.
      i) The leading diagonal.
      ii) Is the matrix symmetrical with respect to the leading diagonal?
      iii) The diagonal in a directed matrix versus an undirected matrix.
   b) Provide drill and practice.

**Sample Problems**
1. Copy the figure and draw the arrow diagram.

![Diagram of routes](image)

2. Complete the table.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Questions**
1. Why are there three routes from A to C?
2. Why are there 2 routes from A to B?
3. Show the leading diagonal.
4. Is the table symmetrical about the leading diagonal?
Extension Activities

1. Find the Matrix which describes these networks:

2. Find the matrices which describe the following network, then write a statement to describe the matrices.

3. Given the matrix, can you draw the network? (work backwards)

Sample Lesson Plan 4

**Topic**  Introduction to Vectors as a means of representing a distance.

**Objectives**  Students will be able to

a) Describe a position relative to a point.
b) Write the coordinate of a point in the coordinate plane.
c) Write the coordinate as a vector.
Prerequisites
1. To plot points in the coordinate plane.
2. To use a protractor to measure an angle.
3. To draw to scale.

Skills and Concepts Presented
1. Drawing angle bearing.
2. Writing coordinates with distance and angles.
3. Plotting a position in the coordinate plane using direction East and North.
4. Reading and writing the position as an ordered pair (length, angle) and as a vector (East, North).

Development
1. Review angle measure (bearing).
2. Introduce the use of a scale (model drawing).
3. Using the picture in the content, have students give the position of the boat using the format (length, angle). Have students draw other positions using variation of the angles and lengths.
4. From the coordinate system shown have students give the position of the ship using ordered pairs (East, North).
5. Introduce Vectors as a means of writing a displacement.
6. Work with students in writing the displacements. For example, suppose the ship moved from position S and its movement is (2/6), then its position relative to the port will be (4/3) + (2/6) = (6/9). Have students represent this position on their graph paper.

Sample Problems For Class Discussion
1. Write down the vectors that represent the following journeys:
   a) from A to B   b) from C to D
   c) from E to F   d) from G to H.
2. The following shows a map of an island:

![Map of an island](image)

a) Write the stages of the journey using vectors.
b) How many stages are there?
c) Add up the vectors of the journey.
d) Show the journey from Port Charles to Jacob’s point via the lighthouse.
e) Give your partner some vectors and have him (her) give your destination.

**Extension Activities: Using Bearings and Scale Drawing**

1. A pilot wants to fly from city C to a city B, a distance of 1200 miles. The city B is on a bearing of 082° from C. Due to a pending storm, the pilot makes a detour and refuels at city A. The distance of A from C is 700 miles and the bearing is 175 degrees. Find the distance of A to B, and the bearing the pilot has to take.

2. (500 miles, 090°) is a journey taken by an aircraft. Find the single journey represented by (500, 090 degrees) followed by (375, 250 degrees).

3. A pilot is to make a round trip from New York calling at three airports (Dulles, Washington International; Atlanta, Georgia; and Cleveland, Ohio.)
   a) Plot the path of the aircraft. (Use an atlas to get the bearing).
   b) What bearing must the pilot take to return straight to New York from Cleveland?

4. Use any three cities of your choice (select some foreign cities).
   a) Draw a graph of the path between them.
   b) Give the bearing the pilot will take for the return trip.

**Latitude and Longitude**

1. Draw a large sketch of the earth, marking in the center, the North and South poles, the equator, and Greenwich meridian.

2. On a sketch of the earth draw in the following.
   a) the 50 degrees N circle of latitude.
   b) the 30 degrees W longitude line.
c) the 60 degrees E longitude line.
d) the point A with latitude 40 degrees N and longitude 30 degrees W.
e) the point with latitude 20 degrees S longitude 10 degrees E.
3. Use a map to locate various cities and write their latitude and longitude as a vector (latitude, longitude).

Notes

2National Council of Teachers of Mathematics, "Curriculum and Evaluation Standards."
3National Council of Teachers of Mathematics, "Curriculum and Evaluation Standards."
9C. A. Congleton and L. E. Broome, "A Module in Spherical Trigonometry," School Science and Mathematics 80, 103-108. This article has presented the topic of spherical geometry in three areas. The article was written as an enrichment lesson for high school students that have trigonometry and possible calculus in their background.

Bibliography

Mathematics

Congleton, C. A. and L. E. Broome. "A Module in Spherical Trigonometry." School Science and Mathematics 80: 103-108. This article has presented the topic of spherical geometry in three areas. The article was written as an enrichment lesson for high school students that have trigonometry and possible calculus in their background.


The School Mathematics Project. Books B, C, and D. Cambridge: Cambridge University Press, 1970. These books have presented the topic of network, matrices and vectors in a form that can be presented to any group of students. For examples and teaching guide the reader is encouraged to consult these books.


**History of Flight**


11
Ship and Airplane Testing:
Physics for High School Mathematics Students

James Francis Langan

1. INTRODUCTION

Here at New Haven at the Sound School we want to integrate the Long Island Sound as a theme into our instruction, to make connections between the material taught in the classroom and what goes on in the Sound. The Sound School is one of the schools of choice offered to high school students by the New Haven Public Schools. Children may choose to come to one of these schools instead of the large, traditional high schools. Long Island Sound leads to topics such as marine biology, boats, and navigation. As a mathematics teacher I look for problems to share with my students. By looking at the methods of solution in one field we may find strategies for solving problems in other fields.

One topic I look forward to is naval architecture, the designing of ships. If we are going to look at boat design, we need to know some physics. What is a center of gravity? What is a center of buoyancy? How do levers work?

A. What Is a Unit?

A unit is the result of a New Haven Public School teacher's participation in the Yale-New Haven Teachers Institute. The Institute provides an opportunity for New Haven public school teachers to write curricula with the assistance of a Yale faculty member and the resources of Yale University. The Institute runs various seminars related to the subjects one teaches. The units are the record of what one accomplished by being in the seminar. One applies in February and finishes by the first week of August.
When one writes a proposal, one has high expectations. "I'll write an explanation that will make it obvious for any student." After one has tried to do it one sees reality. "It doesn't sound so much different from the references." Yes, that is how I learned that I had learned something. The explanations that seemed complicated at the start now make sense. Unfortunately, that means other students will have to put in the time just as I did. I didn't find the magic explanation.

The seminar on aerodynamics was an opportunity to pursue some of the physics related to boats. Aerodynamics is a division of the larger field of fluid mechanics. The rules that apply to air, when the speeds are well below the speed of sound, also apply to water. It is only necessary to take into the account the different properties of the media. Water is more dense and more viscous than air; both, however, are called fluids. The rules for floating boats and balloons are the same. The rule for submarines and airplanes are the same. Boats, however, work on the surface of the water producing free surface waves; this adds some problems that airplanes and submarines do not have to contend with.

B. How to Use This Unit

I want my students to see uses of mathematics. One way students can see uses of mathematics is by reading about engineering projects and their solutions.

I see this unit as something the student can read as a start on the subject. The unit may be broken into sections for reading, or the whole unit may be given to the class. I want discussion with the students on the writing: It is clear? How could it be improved? What was left out? Did some source over-simplify the story? After dissecting this unit it will be their turn to write a report on some technological project.

Learning is a do-it-yourself job. The required work may not be enjoyable. I hope, however, the collateral readings will be enjoyable and fascinating.

I see the student projects centering on the history of engineering, ship building, naval architecture, and technology. Books that are readily available are the Time-LIFE Books, Ships, by Lewis et al. and Thomas C. Gillmer's Modern Ship Design. Both are public library books.

The most important part of the process will be the discussion. Students are all too willing to sit passively as if they were jugs waiting to be filled up. I see the reading as the motivation for the discussion. If the books are interesting enough the students will be willing to share them with one another.

I use this material when we discuss variation in Algebra II. This unit itself mentions direct and inverse proportion. The naval architecture readings give
examples of variation when they discuss laws of mechanical similitude, such as the wetted surface varies as the square of the length on the water line. There are other places that the unit could be used, but I need a starting place. If the students show interest, the project will expand.

II. MECHANICS

There are many stories that educated people are “supposed” to know. These are the stories that tell us the axioms or postulates of our culture. Two examples are Archimedes running naked through the street of Syracuse yelling, “Eureka,” and Galileo dropping two cannonballs of different weights from the Leaning Tower of Pisa. Although historians of science may question the accuracy of the stories, there is no doubt that the stories help us remember the physical principles involved. The first is buoyancy, why boats float, and the seconds tells us that objects fall at a constant acceleration that is not dependent on their weight.

What have I learned that I would like to share with my students? There are a number of stories that illustrate physical principles that everyone is supposed to know. Let us tell them.

There are fundamental principles that need to be known as well. Let us mention them even if we do not teach the topics completely so the students will be prepared to listen more carefully when they meet the principles the next time an instructor presents them.

One topic that I would like to share with my students is called dimensional analysis. Physics is what we can hold, see, and measure. Just what can we measure? We can use a ruler to measure the length of something, we can use a balance to find the mass of something, we can use a watch to time something, and we can use a thermometer to measure the temperature of something. All other measurements are combinations of length, mass, and time. In fact, a thermometer is using length to measure temperature; the length of the column of mercury tells us the temperature. The words “dimensions” and “units” have distinct meanings. When I say a board is six feet long, I have given the units feet to the dimension length.

A. Archimedes: The Lever, Density, and Buoyancy

Archimedes was a Greek mathematician. He was killed by a Roman soldier during the invasion of Syracuse in 212 B.C. You may read about this in James R.
Newman’s collection, *The World of Mathematics*. Two concepts that Archimedes worked on are of interest to naval architects: The lever and buoyancy.

The lever is the first machine. It is the principle of the beam balance, which allows us to weigh things. Scientists look for formulas to describe phenomena. The formula for a lever can be best explained by looking at a seesaw. Two children take a board and support it near the center. Each one sits on an end with the support between them. They now can go up and down. The support is called the fulcrum. What if one child weights more than the other? The heavy end will go down and only go up with much effort on the part of the heavy child. What can be done? Move the board on the support so the heavy child is closer to the fulcrum and the lighter child is farther from the fulcrum. Let \( w_1 \) be the weight of the first child, let \( d_1 \) be the length of the seesaw from the fulcrum to the first child, let \( w_2 \) be the weight of the second child, and let \( d_2 \) be the length of the seesaw from the fulcrum to the second child. The formula for this law of mechanics is

\[
w_1 d_1 = w_2 d_2
\]

When physicists multiply a weight or force times a distance they call the product a moment or a torque. So if you move a weight with a lever and you have to move another weight that is twice as heavy as the first, just use a lever that is twice as long and it will be just as easy to move as the first. This led Archimedes to say, “Give me a place to stand and I will move the earth,” the principle being that to apply more force, use a longer lever.

The second principle is illustrated by the story of how Archimedes tested the crown of king Hiero for the purity of its gold content. Rumor said the goldsmith replaced some of the gold with an equal weight of silver. So the crown weighed as much as it should. How could it be tested for purity? Archimedes was consulted.

Archimedes’ moment of insight occurred while he was taking a bath. He jumped out of the tub and ran throughout the streets yelling, “Eureka!” which means “I have found it!” in Greek. That’s the story, anyway. So what had he found?

Let us ask ourselves the same questions. What happened when his body went into the water? Water ran out of the tub. Water was displaced. How much water was displaced? Two things cannot take up the same space at the same time, so the amount of water displaced has the same volume as the submerged body. Do
equal weights of gold and silver take up the same amount of space? No, gold is
denser than silver. Equal volumes of gold and silver would have different
weights; the gold would weigh more than the silver. So equal weights of gold and
silver would have different volumes, with the gold, being denser, taking up a
smaller volume.

Archimedes found that the goldsmith, indeed, had cheated. Archimedes
measured the displacements of the crown and of two weights, one of pure gold,
the other of pure silver, both equal in weight to the crown. Archimedes found
the crown’s displacement to be between the displacements for the pure gold and
the pure silver.

There is more to the story. Archimedes also weighed the crown in air and sus-
pended under water. He found that it weighed less when submerged. How
much less? The weight loss was equal to the weight of the displaced silver. What
if a body displaced a volume of water that weighed more than the body itself?
The body would weigh less than nothing? No, the body would float. That is the
principle of buoyancy. A body floats when the weight of the water displaced is
equal to the weight of the body.

If we divide the mass of the body by its volume we get its density. Knowing
the density of an object and the density of water we can tell if the object will
float. If its density is less than the density of water then the object floats, greater
than water it sinks.

With these principles it is possible to determine the water line of a boat.
Here is a sample problem. I have a block of wood 8 cm x 10 cm x 15 cm, that
has a mass of 780 gm. I would like to float it with the 8 cm dimension being the
height. How deep would it sink into the water? What is the density of this
block?

One convenient feature of the metric system is that one cubic centimeter of
water has a mass of one gram, so by definition the density of pure water is one
gram per cubic centimeter. The density of the block is

\[
\frac{780 \text{ gm}}{8 \text{ cm} \times 10 \text{ cm} \times 15 \text{ cm}} = 0.65 \text{ gm/cm}^3
\]

So the block is a typical piece of wood; its density is less than one. In other
words, its density is less than the density of water, so it will float.

Since the block weighs 780 grams it will have to displace 780 cubic centime-
ters of water in order to float. If the block is to float with the 8 cm dimension as
the height, then the submerged portion will have dimensions of 10 cm by 15 cm by X cm and will have a volume of 780 cubic centimeters. So find X.

\[
\begin{align*}
10 \text{ cm} \times 15 \text{ cm} \times X \text{ cm} &= 780 \text{ cm}^3 \\
150 \text{ cm}^2 \times X \text{ cm} &= 780 \text{ cm}^3 \\
X \text{ cm} &= \frac{780 \text{ cm}^3}{150 \text{ cm}^2} \\
X \text{ cm} &= 5.2 \text{ cm}
\end{align*}
\]

Consequently the block will float with 5.2 cm of the 8 cm vertical dimension submerged.

This is a demonstration of the principle that allows a naval architect to determine the water line of a boat before it is built. Of course, the submerged portion will be more complex than a block. Calculus will then be needed to calculate the volume of the submerged portion. The architect will also need to know the densities of the materials out of which the boat is to be so that the weight of the boat can be calculated. Again by calculus the volume of the whole boat can be determined.

Archimedes was one of the Greeks who contributed to classical geometry. In fact, they called themselves philosophers, no matter what they were studying—mathematics, science, or what we call philosophy today. The axiomatic method of thinking was their legacy to us. Consider the statement, “Two things cannot take up the same space at the same time.” That is a self-evident truth, that is an axiom! So the laws of science are axioms that we accept because our experience says they seem to be self-evident. If the axioms are true then the consequences of the axioms are true as well. So investigate by doing experiments to see if the consequences are true. If the consequences do not work out, then our axioms do not apply to the real world. The investigations are called experiments.

What Archimedes was doing in our discussion is known as statics, the study of bodies at rest, in equilibrium. Statics is a branch of the larger field of physics called mechanics which includes the study of motion.

B. Other Contributors

Among the people who contributed to the field of mechanics we find Copernicus, Brahe, Kepler, Galileo, and Newton. Yes, those are the names associated with the concept of the solar system. Mechanics is the study of motion, any kind of motion, even the motion of celestial bodies.
Here is a short version of the story. Copernicus said the planets revolved around the sun. Brahe made astronomical observations. Kepler analyzed Brahe's data and came up with three laws:

1. Planets follow elliptical paths with the sun as a focus.
2. A line from the sun to a planet will sweep out equal areas in equal times.
3. The square of the period of revolution about the sun is proportional to the cube of the major axis of the orbit.

Some friends went to Isaac Newton (1642-1727) with the idea that gravitational attraction between two bodies was inversely proportional to the square of the distance between the bodies. The story goes that he had the solution already written out for them. The law of gravity with Newton's laws of motion result in proving Kepler's laws as theorems. Newton had used the calculus that he had invented to do the problem. His friends induced him to publish his results in a book called Newton's *Principia*.

C. Newton's Three Laws:

1. A body at rest will remain at rest and a body in motion will remain in straight line motion, unless it is acted upon by a force to change that motion.
2. The force causing the motion of a body is equal to the product of the mass of the body and the acceleration of the body. \((F = ma)\) where \(F\) is the force, \(m\) is the mass of the body, and \(a\) is the acceleration of the body. Acceleration is defined as the rate of change of the velocity, that is, how fast the speed changes.
3. For every action there is an equal and opposite reaction.

Newton also proposed the Universal Law of Gravity. He stated that the force of attraction, \(F\), between two bodies varies jointly as the product of their masses, \(m_1\) and \(m_2\), and inversely as the square of the distance, \(r\), between them:

\[
F = \frac{G m_1 m_2}{r^2}
\]

where \(G\) is the universal gravitational constant.

There is much more to the story. Who was Leibniz, and what did Galileo have to do with the story?
So Newton's scheme worked; it was applied to celestial bodies and earthly bodies. His work in the area is now called Newtonian Mechanics or Classical Mechanics. When we apply the rules of mechanics to fluids we have fluid mechanics.

III. FLUID MECHANICS

A. The Continuity Equation

One reason I participated in the Aerodynamics Seminar was to find examples using high school mathematics that I could share with my students. The continuity equation is such an example.

When trying to solve a problem we are told to look for things that stay the same. They then can be set equal to each other, giving an equation to solve. Rules like that are easy to state, but examples are easier to understand.

If we have water flowing through a pipe, the water will enter at a certain rate and leave at the same rate; if the quantity pushed in per unit time remains constant, an equal amount of water per unit time will be expelled. That seems like an obvious and reasonable observation. What are we taking for granted in this argument? We are assuming that water is incompressible and that its flow is steady or unchanged with time. This reasoning is using the concept of conservation of mass, namely that in nature mass cannot be gained or lost in a system. A simple, characteristic example of scientific reasoning. So what can we do with it? Let's write a formula.

How would you express the rate of flow? If it were a bilge pump you would say so many gallons per hour. What do gallons measure? Volume. Volume is expressed as cubic units, cubic feet, cubic centimeters, and so forth. Time can easily be changed from hours to minutes or seconds. So the rate of flow could be expressed as cubic centimeters per second. Cubic centimeters per second could also be expressed as square centimeters times centimeters per second. What do square centimeters and centimeters per second each measure? Area and velocity, respectively. So the rate of incompressible flow could be expressed as volume per time equals area times velocity. The velocity would be an average velocity since we are using the total volume per unit time. The water in the center of the pipe goes faster than the water at the pipe wall. Can you tell what area and what velocity to use? The pipes have cross sectional areas and the water has an average velocity. So we could use the area of the entry or the exit opening. Does the argument make sense if we start with the area of the pipe and the average velocity of the water? If we multiply the cross sectional area of the pipe (cm squared) by the velocity of the water (cm/sec), what do we get? Cubic centime-
 ters per second, volume per unit time, a rate of flow. It makes sense both ways. Does it matter what cross sections we use? If our principle that the quantity of matter flowing in is the same as the amount flowing out, then it must also be true everywhere in the pipe. Let us write this as an equation

\[ AV = k \]

where \( A \) is the cross sectional area at a point in the pipe, \( V \) is the average velocity of the water at the same point, and \( k \) is a constant, the rate of flow of the pipe, in our units cubic cm/sec. Since the equation is true for any two points in the pipe we could also write

\[ A_1 V_1 = A_2 V_2 \]

where \( A_1 \) and \( V_1 \) are the area and velocity at one point in the pipe, and \( A_2 \) and \( V_2 \) are the area and velocity at some other second point in the pipe. This equation is called the continuity equation.

The way I visualize the continuity equation is by thinking of a paper wrapper full of pennies. Instead of closing it, fill it full to the ends so no more will fit in. Now try pushing three more pennies in at one end. What happens? Three pennies are pushed out the other end.

We have just shown that the velocity of water at some place in a full pipe is inversely proportional to the cross sectional area of the pipe at that point. That means when the pipe narrows down the velocity of the water goes up. This is something you probably noticed when you put your thumb over your garden hose.

When fundamental principles are stated one should consider them for some time. Ask what the ramifications of the principle are, what else can be proven by it? Think on it long enough so you too can see that it is “self-evident.” After all, how often do you go around repeating the self-evident? If it is self-evident, your listeners can figure it out for themselves.

**B. Dynamic Similarity**

In High School Geometry we study the concept of similarity. If two geometric figures are of the same type with corresponding angles congruent and corresponding sides proportional, then the figures are said to be similar. In physics, if the points
in corresponding positions at corresponding times have proportional velocities and proportional accelerations, then the systems are said to be dynamically similar.

What could the corresponding points be? The ideas of geometric and dynamic similarity can be extended to three dimensional bodies, such as models of ships, of aircraft, of canals, or of river systems. We could do model testing.

Why would we want to do model testing? If we want to design a new ship, we could go ahead and build it and see what happens. This could be very expensive, especially if the design were poor or had some dangerous feature. Instead we can make scale models that are geometrically similar to the full size ship we will build. It is cheaper to run tests on the models since they are smaller and we can build more of them to test more features. We must have a way of transforming the measurements we take on the models to get the values we would have on the full size ship. To be able to transform the drag on a model, for example, to the drag on the full size ship, we need to have dynamic similarity.

Corresponding time should be explained. If the problem being modeled is cyclical in nature, such as the revolutions of propellers, the time for the model will be the fraction (number of prototype rpm over the number of model rpm) of the real time. If there are no cyclical features, find the times for the systems to trace out similar curves. The ratio of those times is the scale factor for time. If we can model time, it is possible to tell how long a machine will last. If we run its model at 20 model cycles to one prototype cycle, the model will wear out in one twentieth the time the prototype will take to wear out.

Model testing is useful; it may save lives. Both lack of model testing and ignorance of model results have led to major loss of life and property. Although there was no loss of life, one famous example is the Tacoma Narrows Bridge. It twisted itself apart; the wind pushed it one way, and each time the bridge reacted, the wind continued to push it in the direction of reaction, making the effect bigger. This is known as resonance, the amplification of the effect.

Mario Salvadori in his book, Why Buildings Stand Up, reports that on May 17, 1854, the Wheeling Bridge over the Ohio River collapsed in a wind storm in the same way as the Tacoma Narrows Bridge did on November 7, 1940. John Roebling, who designed the Brooklyn Bridge, knew of the failure and designed his bridges with diagonal stays so as to prevent the twist. Figure 10 in Paul A. Hanle's Bringing Aerodynamics to America is a photograph of a model of the Tacoma Narrows Bridge in a wind tunnel at the University of Washington; the date, however, is 1941, too late to avoid the disaster. The picture does show the wind-induced waves in the bridge deck. One reason to go to school is to learn from the experiences of those who came before us. Some models may be full size examples that are improved upon in the next version of the design.
How do we keep models dynamically similar? By running the model at the same value of the similarity constant as the prototype. What does that mean? What are similarity constants? Let us answer those questions. There are many similarity constants. Similarity constants are pure numbers, they are dimensionless. They are ratios of various kinds of forces. Three important ones are the Reynolds number, the Froude number, and the Mach number. So if you want your model to be representative, run it at the same Reynolds number or the same Froude number as the prototype. The following paragraphs should make this clearer.

The sources for the following are texts in Aerodynamics and Hydrodynamics, I make no claims to originality. Sources I found most helpful were von Kármán, Prandtl, Rouse, and Wegener, which are listed in the bibliography.

There are various kinds of forces. There is the force of gravity which attracts things to the center of the earth. There are inertial forces. Inertia is the property of bodies in motion to stay in motion until operated upon by another force. Some of the opposing force is due to the viscosity of the medium. When a bead is dropped into a jar of honey it does not fall as fast as it would in a jar of water. We say the honey is more viscous than water. We could form ratios of these forces in various ways. Two of the ratios are the ratio of inertial forces to viscous forces, which is called the Reynolds number, and the ratio of inertial forces to gravitational forces, which is called the Froude number.

The word “constant” needs some comment. The numbers we are talking about have different values for different velocities, different media, and different prototypes. If we are doing testing, we must have the value of the number of the similarity parameter for the model situation equal to the value of the number for the full-size situation. We must keep the numbers equal, keep them “constant.”

Dimensionless variables are a significant topic. Let us first learn what are units and what are dimensions. When we say a board is six feet long, the units are feet and the dimension is length. So the dimension length can be measured in many units: feet, inches, miles, meters, etc. In mechanics there are three basic dimensions: length, mass, and time, symbolized as [L], [M], and [T] respectively. These three are combined algebraically to make the dimensions of other physical variables. For example, velocity has units such as feet per second so its dimension is [L/T], where feet are units for length, per means division, and seconds are units for time. Acceleration is how fast the speed changes; for example, if the speed increased 3 feet per second every second we could say the acceleration was 3 feet per sec per sec or 3 ft/square sec, the dimension of which would be [L/T squared]. In Newtonian physics force is mass times acceleration so the dimension for force would be [ML/T squared]. So the dimensions are multiplied and divided as in Algebra 1. When a new physical variable is presented, the dimension may also be stated along with it. See if you can determine
the dimensions for rate of flow and density as mentioned in the previous section. Can you tell what is the dimension for area?

Before defining the Reynolds, Froude, and Mach numbers, we need to define some notation. The letter \( g \) stands for the acceleration due to gravity \([L/T^2]\). It is a constant. Its value on earth is 9.8 m/sec squared or 32 ft/sec squared. That is the point of the story about Galileo and the leaning tower. The Greek letter (rho) stands for the density of the material under discussion. It is the mass of a unit volume of the material \([M/L^3]\). Density is a property we use with buoyancy to determine the water line of a ship. The Greek letter (mu) stands for the dynamic viscosity of the medium \([M/(LT)]\). The dynamic viscosity of a medium divided by its density is called its kinematic viscosity, symbolized by the Greek letter (nu) \([L^2/T]\). Did you get the dimension for kinematic viscosity?

C. The Reynolds Number

This ratio known as the Reynolds number, \( R_e \), is

\[
R_e = \frac{VL}{\nu}
\]

where \( V \) is the velocity, \( L \) is a representative length such as the diameter of a pipe, the length of a ship, or the chord of an airfoil, and \( \nu \) is the kinematic viscosity. The Reynolds number is named after Osborne Reynolds (1842-1912), a British engineer who did the first work on laminar versus turbulent flow in pipes.

What is the dimension of the Reynolds number? Substitute the dimensions for the defining variables of the number and reduce:

\[
R_e = \frac{VL}{\nu} = VL * \frac{1}{\nu} = \frac{L}{T} * L * \frac{1}{L^2/T} = \frac{L^2T}{TL^2} = 1
\]

The result is that the dimensions of the fraction cancel out, they reduce to one. The Reynolds number is said to be dimensionless, as would any other variable whose dimensions reduce to one.

Let us use the Reynolds number in an example. We want to test a 1/3 scale model of an automobile in a wind tunnel to determine its aerodynamic drag. How fast should the winds blow? The physical relationships are the same
whether the car moves or the wind moves; it is easier to blow air against a fixed car model. Let the subscript \( m \) mean "of the model" and the subscript \( p \) mean "of the prototype." If the Reynolds numbers of the model and the prototype are to be equal then

\[
\frac{V_m L_m}{v} = \frac{V_p L_p}{v}
\]

Since the kinematic viscosity of the air is the same in the tunnel as on the highway we may cancel it. Substituting \( L_m = \frac{L_p}{3} \) we get

\[
V_m \frac{L_p}{3} = V_p L_p
\]

Solving for \( V_m \), we get

\[
V_m = 3 V_p
\]

So the model velocity must be three times the velocity of the full-size car. To model 55 mph the wind tunnel will be run at 165 mph. This is a reason to use large sized models when keeping the Reynolds numbers of the model and the prototype equal. Since the velocity is inversely proportional to its size, the smaller the model the faster the wind will have to be, perhaps too fast.

If the model were small enough we could be required to run the tunnel at supersonic speed. Even if we could (there are such tunnels) we would then have to worry about effects on the model that do not occur at subsonic speeds, such as the air being compressible and thermodynamic effects. The similarity constant for supersonic speeds is the Mach number. We will say more about the Mach number later. When there are forces that have significant effect on the model but negligible effect on the prototype, we have a scale effect. Working with larger scale models helps avoid scale effects.

**D. The Froude Number**

The Reynolds number is not the only similarity constant. After all, viscous forces are not the only forces that act on other systems. When the inertial and gravitational forces predominate then the similarity constant of concern is the Froude
number. This number is also named after its discoverer, William Froude. It is the ratio of the inertial forces to the gravitational forces.

William Froude (1810-1879), a nineteenth century English scientist, was one of the first to use a towing tank to test the designs of ships. Pictures of his apparatus can be found in Rouse and Ince, *History of Hydraulics* (see the bibliography). He wanted to discover the relationship between the forces on a model and the full-size ship. By towing variously sized models of the same design and comparing them to each other, he found that there was no proportional relationship between the resistance of similar models and their sizes. He decided that the resistance was the sum of a frictional force and a residual force. His technique was to determine the frictional force, subtract it from the total force, and get the residual force, which he said was the wave-making force. He determined the frictional resistance by towing boards of various lengths and finishes under water without making waves. He assumed that the frictional resistance \( R_f \) was proportional to the wetted surface area of the ship \( S \) and a power of the velocity \( V \) of the ship.

\[
R_f = f S V^n
\]

His experiments with the boards were to determine the proportionality constant \( f \), which he called the form factor, and the exponent \( n \) for velocity.

While experimenting with different size scale models he noticed that the wave patterns were the same in number along the hull when the ratios of speed to square root of length were the same. This leads to the dimensionless parameter

\[
F_n = \frac{V}{\sqrt{gL}}
\]

where \( V \) is the velocity of the boat, \( g \) is the acceleration due to gravity, and \( L \) is the length of the boat. \( F_n \) is now called the Froude number, in his honor. Froude did his work before Osborne Reynolds, so he did not know about the Reynolds number.

Let us use dimensional analysis to show that the Froude number is dimensionless. Substitute the dimensions of the defining variables (look back) and simplify to get
\[ F_n = \frac{V}{\sqrt{gL}} - \frac{L/T}{\sqrt{(L/T^2)L}} - \frac{L/T}{\sqrt{(L^2/T^2)L}} - \frac{L/T}{L/T} = 1 \]

So the dimensions reduce to one and the Froude number is indeed dimensionless.

Froude's program was to determine the frictional resistances from the wetted surface areas of the model and the ship, determine the residual resistance of the model by towing the model, scale the model's residual resistance up to the full size ship, and add it to the ship's frictional resistance to get the ship's total resistance. The scaling up is where Froude's number comes into the discussion. The residual resistances varied as the displacements when the Froude number for both the model and the prototype were equal. The displacement is the volume of water equal to the volume of the boat below its water line. The boat moves the water, it displaces the water.

If this theory is correct, it can be tested against a finished ship. That is what was done when the Admiralty made the battleship H.M.S. Greyhound available. Froude took the measurements for a model and for the full size ship; the results matched.

If viscous and inertial forces are to be similar, the Reynolds number of the model and the prototype must be equal. If the inertial forces and the gravitational forces are to be similar then the Froude number of the model and the prototype must be the same. Is it possible to have both numbers equal at the same time?

Let the subscript \( m \) mean "of the model" and the subscript \( P \) mean "of the prototype." If the Reynolds numbers are equal then

\[ \frac{V_m L_m}{v} = \frac{V_P L_P}{v} \]

If the model and the ship are both in the same kind of water (salt or fresh) the viscosity terms being equal divide out leaving

\[ V_m L_m = I_m I_P \]

\[ L_m = I_m I_P \]
and

\[ V_m = \frac{V_p L_p}{L_m} \]

If the Froude numbers are equal

\[ \frac{V_m}{\sqrt{g L_m}} = \frac{V_p}{\sqrt{g L_p}} \]

Since \( g \) is a constant it may be canceled and

\[ V_m = V_p \sqrt{\frac{L_m}{L_p}} \]

Setting the two equations for \( V_m \) equal we get

\[ L_m^{3/2} = L_p^{3/2} \]

This equation says the only way the Reynolds and the Froude numbers can be equal is if the length of the model and the length of the ship are equal, that is, if the model is full sized. Does this mean that model testing is impossible? No, just that there are limitations to the modeling process; they are approximations in some aspects. The engineer needs to know what is being modeled and make corrections for the effects that are not being modeled.

Whether the Reynolds or the Froude numbers are kept equal depends on which effects are considered significant. Waves involve gravity, so if waves are involved the Froude numbers are kept equal. If we are submerged in a medium such as air for airplanes and cars or water for submarines and propellers, the Reynolds numbers are kept equal provided the speeds are moderate. If speeds are not moderate then we must consider the Mach number.

Froude leads us to the topic.
E. How to Test Model Ships

At the Sound School we try to integrate maritime topics into our curriculum, to use Long Island Sound as a theme for our teaching, hoping that students will be motivated to greater study of a topic if they see a use for it. Here is some history of naval architecture related to aerodynamics. Aerodynamics and hydrodynamics are both part of one field called fluid mechanics. Many of the principles of fluid mechanics were known before airplanes existed. These principles had been discovered in hydrodynamics. One apparatus of investigation was the towing tank.

Much of the hydrodynamics was motivated by the building and maintenance of canals. In fact Benjamin Franklin built a towing tank to test the observation he had made on the canals in Holland that boats go slower in shallower water. The tank was in fact a narrow wooden trough; the model was towed by a weight falling over a pulley at one end. An illustration of the apparatus is found in the Naval Historical Foundation booklet, The David Taylor Model Basin, A Brief History, which is my source for this section.

Even though Ben Franklin was a founder of the United States, the U.S. Navy did not get Congress to approve funding for a tank until 1896. The tank was built at the Washington Navy Yard under the supervision of Naval Constructor David Watson Taylor who directed it for the next fifteen years. Much significant work was done.

The claims of the advocates of model testing were substantiated early on. In 1902 two armored cruisers of 14,500 ton displacement were designed at the Model Basin. They were 820 tons heavier than similar predecessors but were able to cruise at 22 knots with less horsepower while consuming less fuel.

Taylor instituted the practice of using wooden models instead of wax models as used by other naval architects. This gave more accurate measurements, and avoided models melting in Washington, D.C. summers. It was much more expensive, however, $80 against fifty cents for wax that could be melted down and used again. He was responsible for the bulbous bow to dampen the bow wave, thus decreasing wave resistance. The bulbous bow is like a torpedo sticking forward from the bow just at or below the water line. This type of bow was first used on the USS Delaware in 1907 with great success. On field trips in New Haven harbor with Sound School students, we have observed the bow waves of freighters and tankers. The crest of the bow wave is in front of the bow, not at the bow. The bow does not “cut” the water. There is a trough, a depression in the water, at the bow.
Doing this project I had hoped to answer the question, "What does a towing tank measure?" Here is what I learned.

If we were to attach two models to the ends of a rod and tow the rod from a line attached to its center, what would happen? Most likely, one model would move forward and one would hold back. The model that held back would have more drag than the one that went forward. If the two models were equal in drag, the rod would be perpendicular to its tow line. We are back to Archimedes and a balance, the lever.

That is the idea of a towing tank. Instead of using two models, we put weights at one end of the rod to balance the force of the model. Furthermore, more balances are used because there are more forces to be measured. Our hypothetical example only measured the force in the direction of the towline. There are six motions for a boat, three linear and three rotational: surge, sway, heave, pitch, roll, and yaw. Surge is the linear motion fore and aft. Sway is linear motion in a sideways direction. Heave is the linear motion in a vertical direction. Pitch is rotational motion in which the bow goes down and the stern goes up, or vice versa. Roll is the sideways rotation. Yaw is rotational motion about the vertical axis.

So a system is designed to suspend the model with linkages for the six motions. Since the system is going to move, the balances will need to be damped so the motion of the apparatus does not disturb them.

F. The Mach Number

The Froude number is of concern when we have gravity waves. When we deal with an elastic medium we have pressure waves. Sound is a pressure wave.

The ratio known as the Mach number is

\[ M = \frac{V}{a} \]

where \( V \) is the velocity of flow and \( a \) is the speed of sound in the medium. The Mach number, named after the Austrian physicist Ernst Mach (1838-1916), is the square root of the ratio of inertial forces to elastic forces. The Mach number is of concern when the medium is not considered incompressible, as when we assume that at high speed an object's motion will compress the air.

The Mach number tells us when we have supersonic speed. If something is going faster than the speed of sound we have a Mach number greater than one. The object is moving faster than the sound it makes, so it arrives before it is
heard. The speed of sound in air is approximately 1100 feet per second while in water it is approximately 4700 feet per second.

Supersonic motion appeared prior to the recent invention of high speed aircraft. Bullets and artillery shell can move at supersonic speed. In fact Benjamin Robbins (1707-1751), the inventor of the ballistic pendulum, found that increasing his powder charge increased his range, but only so far; at some point it became inefficient. His projectiles were approaching the speed of sound and the drag was increasing significantly.

IV. EXAMPLES FROM HISTORY

The reason for this historical material is my desire to give my Sound School students some knowledge about ships and the problems of building them. We learn from what has gone on before our time. This is material for the students’ frames of reference and background information. A math teacher can afford to show students that he is interested in other topics, and the material ties in with the theme of the school.

A. The Great Eastern

The technological “giant steps” of any historical period determine the topics of scientific research for that period. The Great Eastern was one such giant step. It was a ship “before its time.”

Construction of the Great Eastern started in 1854, her launching began in November, 1857, and she finally floated at the end of January, 1858. She was 680 feet long; the next longest ship of her day was 380 feet. Her length was not exceeded until the Oceanic in 1899, and her tonnage was not exceeded until the Lusitania in 1906. The reason it took three months to launch her was that metal rails were used for the ways and the cradles were iron shod. So much heat was generated by the friction of iron against iron that the cradle shoes and the rails welded themselves together in November at the first attempt. The ship was jacked down the ways an inch at a time after jacks were designed and built.

She was the only vessel ever built that had sails, paddle wheels, and propellers, with the paddle wheels and propellers having their own independent engines. She burned a ton of coal per mile. She had a capacity of 12,000 tons of coal. She was under powered; she had about 2600 horsepower with a top speed of 14.5 knots on a displacement of 27,000 tons. Remember, no one had ever
done this before; there were bound to be mistakes and unforeseen problems. All of her problems pointed out the need for even more scientific investigations. Her builders had been successful in their previous ventures building other ships, railroads, and bridges.

One engineer associated with the Great Eastern was William Froude. From his experiences grew his life's work, the study of the powering of ships. Another person to research is J. Scott Russell who designed her and built her in his ship yard. The name that most people associate with the Great Eastern is Isambard Kingdom Brunel, the owners' technical advisor and probably the top engineer of the time. It is a question of historical research as to how much Brunel contributed to the design; it is called "Brunel's great ship" and its misfortunes are said to have killed him.

One success of the Great Eastern was the laying of the transatlantic telegraph cable after the Civil War. To learn more, see the article by Chiles in the Fall 1987 issue of Invention & Technology.

Another reference to see is The Great Iron Ship by James Dugan. Here you will learn that the Great Eastern was launched broadside. She was double hulled to six feet above the water line. In fact, her double hull saved her. On her first voyage to the United States she hit an unchartered rock pinnacle which tore a hole eighty-three feet long and nine feet wide in the outer hull. The rock is still known as the Great Eastern Rock after the ship that found it, the only ship big enough to find it. The hull was repaired by using a cofferdam so the work could be done while the ship was afloat, another feat of engineering.

B. Turbinia and Cavitation

In search of more speed, more efficient engines were built and placed in ships. The first turbine-powered ship was Sir Charles Parsons' Turbinia built in 1894. Parsons had built the first successful turbine to power a dynamo, an electric generator. He had done model tests and had great expectations for the ship, since the turbine was so powerful.

The results were disappointing. The highest speed recorded was less than 20 knots. The problem was cavitation, a phenomenon recognized and named by William Froude. The propellers were spinning at 18,000 rpm, so fast that the water pressure decreased, forming bubbles, a cavity. The power was going into making bubbles instead of pushing the boat.

The remedy was to operate at lower rpm with more turbines and propellers. The original design was one turbine with one shaft of three propellers. The suc-
cessful design used three turbines which each had a shaft turning three propellers, and it achieved the speed of 34.5 knots in 1897.

More information can be found in the literature listed in the bibliography, especially the LIFE book Ships.

**Student Bibliography**

I claim my students will find these books and articles to be readable. I believe the students will also find them interesting.


Teacher Bibliography

These are some of the references I consulted. Some students may find them of use too.


Students are generally introduced to topics of diversity and heredity in 7th and 8th grade science classes. These topics are explored further in a variety of Biology courses during the first or second year of high school. This unit is aimed primarily at students in the upper grades of high school for whom an interdisciplinary setting might provide rich interplay between scientific evidence and broad reaching ideas and questions about evolution.

In my school, a magnet public high school of about 240 students, I have undertaken the development of just such an interdisciplinary science and humanities course with one of my colleagues from our English Department. During one quarter of the year (nine weeks) students can enroll in an intensive seminar of this nature which meets for three hours daily. Although this may seem to most teachers to be an enormous amount of time to prepare for, it offers exceptional opportunities for extended study, research, writing, and discussion. In this unit I present an overview of the science curriculum for this seminar; my colleague has prepared separately a plan for the humanities curriculum. Since we teach together for the entire three hours daily we blend ideas and draw upon each other as resources throughout the course.

For the purposes of organization, I have divided the unit into three themes:

I. The Origins of Life: Creation vs. Science?

This first theme sets the stage for inquiry and seeks to engage students at a variety of levels, providing "hooks and handles" for the humanities component of the interdisciplinary seminar through readings from several creation myths and posing some "unanswered questions in science."
II. Theories of Evolution

A brief background in development of theories of evolution—from the early Greek philosopher-scientists to the modern day molecular biologists. After Darwin two lines of study developed in pursuit of knowledge about human evolution—fossil hunters and geneticists.

III. The Chemical Structure of Life: The Human Genome

Evolution from the perspective of late 20th century theorists—the molecular geneticists. The human genome, the pinnacle of chemical organization of human life, provides a glimpse, or snapshot, of the leading edge of present-day evolution among humans and the arena for mutation and change in the future.

I. THE ORIGINS OF LIFE: CREATION VS. SCIENCE?

Objectives  Students should be able to
1. explain the purpose of creation myths.
2. compare and contrast two different myths of creation and identify common themes and differences.
3. explain the difference between “creationist” and scientific views of life.
4. compare and contrast “hypothesis” and “theory” and give an example of each.
5. distinguish the characteristics of science from pseudoscience.
6. explain how a scientist works to resolve an “unanswered” question of science.

Strategies
1. Copies of several creation myths will be provided for study. Small groups of students will read, discuss, and present each myth to the class.
2. Reading of examples and discussion of relationships among biology, technology, and ethics.
3. Lecture: Introduction to Charles Darwin’s life and work as one example of a scientist using observation—hypothesis—experiment—prediction—theory.
4. Development of concept map to distinguish between science and pseudoscience.
5. Written summary of class discussion of the Huck Finn and Jim debate over the origin of stars.
6. Group study and discussion of unanswered or “open” science questions—written summary by students for sharing with the class, based on reading of articles:
   a. Did the Universe Have a Beginning?
   b. Did Life on Earth Arise by Chance?
   c. Where Did the First Animals Come from?
   d. Do We Share Common Ancestry With Apes?

Discussion

We had the sky, up there, all speckled with stars, and we used to lay on our backs and look up at them, and discuss about whether they was made, or only just happened—Jim he allowed they was made, or only just happened; I judged it would have took too long to make so many. Jim said the moon could a laid them; well, that looked kind of reasonable, so I didn’t say nothin’ against it, because I’ve seen a frog lay most as many, so of course it could be done.

In Mark Twain’s classic American novel, *Huckleberry Finn*, quoted above, Huck and Jim ponder the world and how it came to be. Without knowing much science or philosophy or religion, they wrestle with the profound question of whether some ultimate purpose lies behind the world. Is all existence the result of a creator—God, or of self-directed forces of happenstance (or, perhaps, to some combination of “first cause” and random after-effect)?

At the heart of wisdom is the search for an answer to that question. If stars “only just happened,” then nature can be seen as merely due to random, accidental events and processes. This answer might imply that human beings are only physical objects without value or intrinsic worth. Likewise, if stars were “made” then perhaps all nature was meant to be. All living things might be viewed as purposeful, bearing the signs of a creator’s intentions. Life takes on a sacred dimension. Humans, especially, become obligated to treat each other and their whole earthly environment with dignity and respect. A sense of connectedness and interdependence among living organisms is a common thread which runs throughout creation myths from widely different cultures. Perhaps a resurgence of this awareness accounts in part for the recent large-scale outpouring of concern for the future of the earth.

But there is a danger in over-romanticizing this “creationist” interpretation of life. When Huck and Jim decide that the moon gave birth to the stars, their
answer, however satisfying at the moment, makes no sense from a scientific standpoint. It is contradicted by too much evidence.

The welfare of any modern nation depends on its science and technology. U.S. industry, national defense, even health, rely on progress in fields such as geology, physics, and genetics. Science implies scientists, who must be accurately taught. In schools and colleges, there can be no contamination of the teaching of science by irrelevant philosophies or prejudices, no matter how time honored these may be.3

Philip Dunne, in the above statement published recently, emphasizes our current predicament as science educators: Science teachers today are often wary of an ongoing controversy—the American public seems divided over what students should be taught about origins, particularly human origins. Yet when science is properly taught, questions of origins become opportunities for classroom dialogue. Students who learn to distinguish between scientific discoveries and the assumptions buried within them gain a better appreciation of what science is. Similarly, an understanding that a scientific theory is not a "guess," but a well-tested hypothesis which not only explains evidence but predicts future data, can eliminate some of the popular confusion which posits belief in the Bible, Koran, or other religious canons as equal to "belief" in science.

For some of the deepest questions about life's meaning and purpose, religious faith is part of the investigative process. The methods of science seek to investigate the how and when, but cannot step outside nature to probe why things exist or whether a greater intelligence lies behind our own existence.4 “The mystery of creation, as every real scientist is quick to admit, is not one that science is capable of solving.”5 For many students, however, the two sets of questions (“how” versus “why”) appear confused and entangled.

Scientific knowledge keeps expanding and thus students must always be taught some things that were unknown when their parents went to school. But good science teaching means more than conveying information about what scientists have learned. A more vital task is teaching the particular way that scientists look at the world. The fact that this way may not be fully appreciated by even technologically sophisticated students makes the prospect quite challenging. Valid scientific conclusions are based on valid evidence. Students need to learn how to evaluate evidence as scientists are trained to do—essentially taking all relevant facts into consideration while searching for still more evidence. How the world works is what scientists are continually investigating, and research has led to tremendous improvements in food, medicine, health care, computers, etc. However, in gaining knowledge, scientists have also challenged the way people
think and this sometimes causes problems. To provide both rationale and guidelines for constructive classroom dialogue, students will need to clarify terms and practice the skill of identifying similarities and differences between the concepts of "science" and "pseudoscience." Drawing a concept map as a lecture/note taking exercise may help achieve these goals.

**Creation or Evolution—A False Dichotomy**

Creation myths and stories—the mineral-rich bedrock of religious thought—offer explanations for the origins of human life as experienced by the peoples from whom the myths developed. Whether serendipitous act, Supreme Intelligence, godly conflicts, or other "first cause" is identified in the myths, they have in common the attempt to explain human interactions and foibles, interdependence and relationships among living things, relation of life to earth, or purposes of life. The heart of religion is searching for meaning and in this quest curiosity about what came before as well as what might follow is often addressed.

In biology, evolution is often presented historically as an idea or concept which gradually replaced the early 19th-century concept of a "static" creation in which not much had changed since "the beginning." Geological evidence accumulated during the 18th and 19th centuries to such an extent that scientists became convinced Earth had a very long history of changes. Examination of the evidence for physical changes of the earth revealed forms of life that were no longer existent. None of the present life forms had been on the earth throughout its entire history and human beings seemed to be newcomers to a comparatively very old planet.

It is commonly believed that science and biblical (revealed) religion have always been at war with each other. Such belief is not supported by historical study. Western science and religion went hand-in-hand in the reading of earth's history for centuries. The static view of the world had been the commonly accepted interpretation of both the physical data and the biblical creation story. It is reasonable to venture that science did not advance until scientists overcame their religious assumptions and viewed evidence from a new perspective.

Perhaps, surprisingly, biblical imagery—an orderly creation by a dependable, consistent God—was one factor that freed the reins of science and gave a strong push toward development of understanding of the natural world. In a world which religion had proclaimed both "good" and the product of Supreme Intelligence, observation, measurement, description, and prediction were both possible and necessary. Galileo, a devout Christian, is reputed to have said that the Bible
“taught how to go to heaven” but science explained “how the heavens go.” (Of course, it must be noted that Galileo spent the last years of his life under virtual house arrest because he refused the Roman Catholic Pope’s demand that he repudiate his observations of the orbits of planets about the sun, in contradiction to official church doctrine that the earth is the center of the universe. It was not until the early 1980s, 300 years after Galileo’s death, that the Roman Church officially acknowledged modern science by quietly publishing an edict pardoning Galileo!)

Even in Darwin’s time, many religious believers accepted evidence for great changes over long periods of geological time without losing faith that such changes were ultimately the work of a Supreme Being. They were comfortable with separating questions of when new forms of life appeared from questions of how this happened. “The modern picture of how life changed over time was developed by geologists who believed in divine creation. The geologic column and the basic facts of fossil succession were established in science (and accepted by most theologians) by about 1840, some twenty years before Darwin proposed a mechanism to explain how such changes had taken place.” Human interest in evolution had always been more complex than simply the opposition of scientific versus religious viewpoints. As legal historian Edward J. Larson has pointed out, science teachers deal not so much with science itself but with “public science”—a compromise between scientific thought and public policy which has a complicated history.

After the famous Scopes trial during 1925 in Tennessee, evolution nearly disappeared from American high school textbooks, reappearing only after the Soviet Union launched Sputnik in 1957. Sensing an urgent need for improved mathematics and science education, the federal government funded a variety of curriculum development projects including the Biological Sciences Curriculum Study (BSCS). Several high school biology texts produced by BSCS were integrated around evolutionary concepts. BSCS has kept up with the explosive growth of information and ideas in biology since the first publications and its sixth edition of Biological Science—A Molecular Approach, published in 1990, offers an exceptionally thorough treatment of current biological concepts for advanced high school students. Although evolution remains a key organizing concept, the latest text has been broadened to include among its unifying themes diversity, genetic continuity, environment, science and society, history of biological concepts, and science as inquiry. This text is most highly recommended for students studying topics in genetics and the unfolding of evolutionary thinking.

Even with the virtually universal acceptance by scientists of evolutionary theory and the publication of highly acclaimed, authoritative, and clearly
explained texts such as the BSCS editions, there is still some lingering controversy over human origins and evolutionary development in the realm of "public science," which is, after all, where we all teach. Within the last two decades dedicated, well-organized groups have promoted the teaching of "creationism" or "creation-science"—perhaps the best example of "pseudoscience" since Midas and the alchemists. Numerous court battles have been waged in attempts to promote "theories of creation" as deserving of equal time with theories of evolution in science classrooms. In every case, culminating in 1990 with the U.S. Supreme Court decision Edwards v. Aguillard, the creationists have been defeated, primarily because creation concepts do not fit the fundamental definition of science which holds that theory derives from data collected through observation and experimentation. Every step of the scientific process must be open to scrutiny, review and reproducibility of results. As the old joke goes, "God never secured tenure among the scientific community because He or She performed an experiment which no one has been able to repeat, peers could not be found to review the work, and He or She only published one book!"

As teachers of diverse middle and high school students, we must recognize that we are treading on fascinating but tender ground when we raise questions about human origins. In the world of public science, integrity of our scientific training demands that we teach that scientists defend evolution because they regard it as a key biological concept. Meanwhile, many American citizens cherish creation as a basic religious doctrine or concept. Direct conflict between these concepts or world views can erupt at any time in discussion or can underlie a student's responses in writing. Integrity to our overall pedagogical training demands that we be sensitive to our students' wrestling with a controversy—at whatever level it grasps them. I urge teachers to "seize the opportunity," however it presents itself, to move students along in their understanding of the concepts and in their sensitivity to how they and their classmates feel about the nuances and implications of various theories and ideas. Standard techniques for guiding classroom discussion will be helpful: a brief review of seven suggestions focused on evolution has been prepared by the American Scientific Affiliation and may prove a valuable teaching resource for this unit.

**Conclusion**

Writers of mythologies, free to roam the breadth of human imagination, are "limited" by the extent of their linguistic expression. Modern scientists—even
armed with vast new technologies—are limited by the constraints of a discipline
which requires inquiry to meet rational, quantitative standard. Yet math and sci-
ence have in common a searching, investigative outlook toward life. As paleon-
tologist Stephen Jay Gould recently stated:

. . . there are about half a dozen scientific subjects that are immensely
intriguing to people because they deal with fundamental issues that disturb
and cause us to wonder . . . [scientific study of] evolution is one of those sub-
jects. It attempts, insofar as science can, to answer the questions of
what our life means,
why we are here,
where we come from,
who we are related to,
what has happened through time, and
what has been the history of this planet.
These are the questions that all thinking people have to ponder.10

II. THEORIES OF EVOLUTION

Objectives Students should be able to
1. outline the history of thinking about evolution.
2. give examples of the evidence used to develop and defend theories of evo-
   lution.
3. identify several key thinkers in the history of evolution and their contribu-
   tions to the debate.
4. explain the differences between Darwin’s and Lamarck’s theories.
5. explain the meaning of “natural selection” and give an example of its oper-
   ation as a mechanism of evolution.
6. apply Darwin’s theory to the history of human evolution, with particular
   attention to differences between Neanderthals and Cro-Magnons.
7. draw a timeline of the hominid family tree.
8. explain the scope of modern molecular biology.
9. compare and contrast the two strands of scientific study of human origins—
morphology and molecular biology.

Strategies
1. Watch Smithsonian video, “Tales of the Human Dawn,” and construct a
timeline of the hominids as a small group exercise.
2. Research and construct a timeline of the early ideas of evolution.
3. Read selections from BSCS, Chapter 1, and draw a concept map to compare and contrast Darwin's and Lamarck's theories.

4. Develop a “Who’s Who” of Evolution chart—individual student research and brief reports to the class.

5. Read the “Lucy” article by Johanson on the discovery of the most complete Australopithecine fossil.

6. Oral reports on key scientists and discoveries in development of molecular Biology.

7. Watch the movie “Race for the Double Helix” and discuss the significance of discovery of DNA molecular structure for evolution.

Discussion

Evidence for evolution has become so pervasive that to inveigh against it is similar to King Canute requesting the retreat of the tide.11

In 1977, William V. Mayer, director of the Biological Sciences Curriculum Study, could make the above claim with no dispute from the scientific community and strong reaction only from religious special interest groups within the larger population. This was not always the case, however.

The publication in 1859 of Charles Darwin’s Origin of Species touched off such broad debate and publicity about evolution that it still echoes in the public press and popular culture today—overshadowing, unfortunately, the great scientific strides in understanding and collection of evidence in the 100 years since Darwin. As one entertaining illustration of this point a class session might be spent analyzing, discussing, and sketching cartoons from a variety of popular artists (Gary Larson, Jim Davis, Burke Breathed) who make their bread and butter from humorous depictions of “Darwinian” evolutionary ideas. “Darwin” and “evolution” have become so inextricably linked in common lore that it may come as a great surprise to students to learn that evolution was a concept established long, long before Darwin and that “the current status of evolution bears about the same relationship to Darwin [and his finches] as today’s quantum physics holds to Newton [and his apple].”12

Attempts to explain the origin of life and the diversity of living things are as old as human history itself. In ancient myths can be found the strands of searching for answers to evolutionary questions. But not only myths reflect the roots of this quest. Students will possibly be interested in tracing the line of scientific theorizing about life as sketched in the time line below.13

The earliest written records of the Greeks reveal formulation of hypotheses about evolution:
636-546 B.C.

*Thales*, an early philosopher, theorized in writings about the origin of life.

611-547 B.C.

*Anaximander* conceived the idea of gradual evolution from a formless chaotic condition to ordered, organic life. He even held a view of adaption and transformation of aquatic species to land.

495-435 B.C.

*Empedocles* outlined a concept of gradual evolution—plant species preceding animals and better adapted forms replacing others. (William Mayer makes a case for Empedocles as a more appropriate choice than Darwin as the founder of the evolutionary idea.)

The emergence of the Christian Church with its doctrinal control promoted the dogma of “special creation”—essentially a literal interpretation of the biblical Genesis story. This did not, however, completely stifle attempts by some of the early and later church theologians to reconcile the idea of evolution with scripture:

331-396 A.D.

*Gregory of Nyssa*, although believing that God created the fundamental properties and laws of nature, believed that present existence developed gradually out of chaotic material, a viewpoint similar to that of Anaximander.

335-430 A.D.

*Augustine*, among his many writings, developed an interpretation of the biblical account of creation as allegoric.

1225-1274 A.D.

*Thomas Aquinas*, an Augustinian scholar, supported his views and suggested that the earth had received the power to produce organisms, further questioning the Genesis creation ordering and time frame.

By the late 16th century, scientific and philosophical thinking in the west was no longer under total control of religious authorities. Alongside a rising movement for reform within the Christian Church came an upsurge of early enlightenment philosophy aggressively seeking to stretch the boundaries of human understanding.
1561-1626 A.D.

Francis Bacon, the English philosopher, revived the idea of evolution during this time of challenging the dominant religious worldview. With spreading enthusiasm, Descartes (1596-1650), Leibniz (1646-1716), Kant (1724-1804), and others pushed open the doors of inquiry which led the great naturalists of the 18th and early 19th centuries to explain how evolution had occurred.

1707-1778

Carl Linneaus, while not specifically examining evolution, developed the system of classification of plant and animal kingdoms which is the basis of modern understanding of relationships and diversity.

1707-1788

Lacépède de Buffon contributed the idea that environments can directly modify plant and animal structure, and that these changes may be conserved through heredity.

1731-1802

Erasmus Darwin, the grandfather of Charles, raised questions about organisms' internal source of adaptations, rather than the impact of the environment. He recognized the importance of a struggle for existence, but did not carry this idea far enough to propose "survival of the fittest" (leaving that as a legacy to his grandson!). Erasmus did, however, challenge the concept of a "young earth" and argued, along with the Scottish geologist James Hutton (1726-1797), that millions of years would be required for rock formation and evolutionary processes.

1744-1829

Jean Baptiste Lamarck extended Buffon's ideas to propose a theory that a change in environment produces a need for change in animals and that acquired characteristics in one generation will be passed on to the next. (This well-developed theory should be carefully compared with the Darwin/Wallace theory of evolution by natural selection.)

1797-1875

Charles Lyell, another British geologist, developed the theory of "uniformitarianism" regarding natural phenomena. "The present," he said, "is key to the past"—natural forces that created the world are still at work and change is
a slow, unending process. Although speaking directly in reference to development of physical features of the earth, Lyell had a great influence on Charles Darwin’s thoughts about plant and animal evolution.

1809-1882

Charles Darwin did not originate the concept of evolution, as should now be obvious. However, along with Alfred Russell Wallace (1823-1913), he developed the theory of evolution “by natural selection.” Darwin’s theory was based almost entirely on inferences rather than verification of hypotheses by experiment. “It stands as a unique triumph of this scientific method and has become essential for comprehension of biology as the atomic theory is for chemistry and physics.”

Two decades before publishing The Origin of Species, Charles Darwin wrote in his notebook: “Man in his arrogance thinks himself a great work, worthy the interposition of a deity. More humble and I believe true to consider him created from animals.” If any one aspect of Darwin’s outlook touched off the Victorian maelstrom of reaction to his theory, repercussions of which are still felt today, it was this suggestion of the relationship of humans to the rest of nature.

Two main strands of scientific inquiry have developed over the century since Darwin’s publication: paleontology and genetics.

The first, which students are most likely to be familiar with, is the search for fossil evidence linking present day human morphology to earlier, less evolved hominids. The Smithsonian video, “Tales of the Human Dawn,” and recent articles from weekly news magazines will provide ample material for student discussion of human ancestors and the current thinking regarding the human family tree.

The discovery of “Lucy,” the most complete Australopithecine fossil, as described by Johanson, makes the field work of paleoanthropologists appear as lively as any successful treasure hunt. For students who wish to pursue further this area of science, the work of Louis and Mary Leakey or their son, Richard Leakey, will provide interesting topics to research. Historically, worth studying is Thomas Henry Huxley (1825-1895), the British zoologist who defended Darwin’s theory of natural selection, who asserted early on that he believed humans evolved from apes. Of interest in American science is George Gaylord Simpson (1902-1984), a paleontologist who classified the evolution of mammals and showed in his work that the fossil record is compatible with Darwin’s theory of natural selection.
As mentioned previously, the idea of human evolution is deeply rooted in popular culture and is reflected in stories, movies, and humor of all types. It will be particularly helpful to students who may range from ambivalence to firm beliefs to help them understand that thorough scientific inquiry is ongoing regarding human ancestry, and that theories will serve only as long as they can stand the test of further observations and research.

The second stream of scientific inquiry regarding evolution has given rise to fields of study and disciplines unknown to Darwin. Darwin would have been quite at home with the paleontologists, biogeographers, anthropologists, and comparative anatomists of the first stream of study. He would be astounded, perhaps, to see the evidence accumulated in the 20th century by cytologists, molecular geneticists, biochemists, and molecular biologists. A brief history of the development of this scientific strand will set a context for student study of modern genetics:

1882

*Walter Flemming* published his results on the study of cell mitosis, detailing the role of chromosomes in cell division.

1884

*Gregor Mendel*, within five years of the publication of Darwin's world-shaking treatise, *The Origin of Species*, developed a theory of inheritance based on carefully controlled experiments with pea plants. He discovered that parents can pass on characteristics to their offspring through the action of discrete units of inheritance (named “genes” by the Dutch geneticist *Wilhelm Johannsen* in 1909), each controlling a specific trait.

1900

*Hugo De Vreis*, a Dutch botanist, concluded that evolution was the result of the sudden appearance of new varieties (which he called mutants) and not the natural selection of shifting variations proposed by Darwin.

1903

*Walter Sutton* observed that in cell division producing sperm or egg cells, each gamete receives only one chromosome of each original pair. He recognized that chromosomes must be the carriers of the Mendelian heredity units and hypothesized that parental sperm and egg each contribute one chromosome to each new individual.
1910

Thomas Hunt Morgan developed studies on the chromosomes of the fruit fly (Drosophila melanogaster), and by 1920 he and other researchers firmly established the chromosome theory of heredity. Further work showed that chromosomes are regular linear arrangements of genes.

1931

Barbara McClintock demonstrated that gene order in chromosomes can change by rearrangements and that specific traits in strains of corn are tied to their genetic distribution.

The natural selection ideas of Darwin and the De Vries mutation theory could now be seen as complementary—“natural selection was found to be picking and choosing among variations in the genotype to produce effects for the whole organism.” Genetics and evolutionary theory merged in the 1930s, contributing to the formation of new fields of study (e.g., population biology, population genetics, molecular genetics, biochemical genetics, molecular biology). The final important key in this development was the merging of genetics and biochemistry with focus on the molecular basis of life: molecular genetics explains the mechanisms behind Mendelian genetics while molecular biology concentrates on the structure of cell components to uncover the “code” that determines the characteristics of an organism.

1944

Oswald Avery, Colin MacLeod, and Maclyn McCarty discovered DNA (deoxyribonucleic acid) as the material of the gene. DNA is a long chain molecule made up of four different kinds of molecular groups (nucleotides).

The leaps in scientific understanding that occurred between 1859, when Darwin published Origin of Species, and 1952, when a group of research scientists knew that DNA was the very controlling molecule of life, are of tremendous significance. (For students seeking to understand the role and importance of scientific inquiry in explaining life processes, a brief study of any of the key investigators named might prove informative.)

Immediately after the biological importance of DNA was recognized, its physical structure was discovered:

1953

James Watson and Francis Crick determined the structure of DNA as a “double helix”—a sort of twisted ladder shape—with spines made of sugar and
phosphate and rungs made of pairs of the four bases adenine, guanine, thymine, and cytosine.

1958

Meselson and Stahl, investigating how the DNA molecule manages to reproduce itself so exactly as cells in a developing organism divide and multiply, confirmed that the double spiral “unzips” along its length and nucleotides then link up with each half of the chain to form two duplicates of the original model.

The modern age of molecular biology, which has been chiefly concerned with how genes control cell activity and how proteins carry out tasks such as DNA and RNA formation, began with Watson and Crick’s determination of the helical structure of DNA. The technical and conceptual developments over the past three decades deserve far more treatment than can be included in this unit. This unit does, however, seek to establish the background and context from which students may launch into future study of genetics and biology (hopefully at undergraduate and graduate levels).

It is not unreasonable, once a common vocabulary and language of discourse has been established, to introduce very recent discoveries, techniques, and possibilities. Today the study of DNA has been revolutionized by procedures collectively referred to as “gene cloning” and “recombinant DNA technology.” DNA from any organism can be cut into reproducible pieces, joined to plasmid DNA, and introduced into bacterial hosts for culturing and reproduction on a large scale.

The breakthroughs and benefits for medical science are constantly in the news and will be familiar to many students and certainly deserve study and discussion to relate to basic knowledge and familiar models. Researchers at Yale University and in several local companies are available to meet with students and share with them their excitement about developing potential cures for everything from the common cold to deadly cancers and AIDS.

Have molecular biologists displaced Darwinian ideas about evolution? Hardly. It might be more accurate to say that the focus has shifted with advances in concepts and technology, but the fundamental theory remains much the same. Whereas Darwin studied animal morphologies (e.g., the famous finches’ beaks), today’s theorists study minute structures within cells thanks to electron microscopy, gene splicing, and electrophoresis techniques, among others.

The discovery of DNA provides at least a new round of tentative answers to questions concerning heredity, origins of diversity in life, and animal and plant development. In the argument of one recent text, the discovery that DNA is the universal genetic material of cells suggests that
1. Early evolution must have depended on development of a cell carrying sufficient instructions in its DNA to grow;

2. The random variation and selection proposed by Darwin and Wallace that led to changes in species must have resulted from random changes in the DNA;

3. Faithful reproduction of DNA from generation to generation causes "like to beget like";

4. The programmed instructions in the genetic endowment in DNA underlie the development of every new plant or animal.\textsuperscript{20}

**Conclusion**

An interesting way to draw together various ideas in the history of evolution would be an examination of the debate currently stirring in popular science circles concerning the origin of modern humans. Billed by Discover magazine as "the big battle between bones and genes,"\textsuperscript{21} this is a case study of the quest for an answer to the same question by two very different branches of science—paleoanthropology and molecular biology—each operating with its own assumptions, techniques, and rules. DNA exists in human cells chiefly in the nucleus. Outside the cell nuclei, however, are rod-like mitochondria within which there is also a form of DNA. This "mitochondrial DNA" is unique in that it apparently is inherited only from the mother. (Nuclear DNA is combined genetic material from both mother and father.) The only differences between mitochondrial DNA of a child and that of its mother, grandmother, or great-grandmother are the result of random mutations, according to evolutionary theory. Vincent Sarich and Allan Wilson, two biochemists at Berkeley, have hypothesized that mutations occur across millennia at a steady rate, establishing a kind of "molecular evolutionary clock."\textsuperscript{22} By studying genetic differences and calculating backwards in time with their clock, Sarich and Wilson establish dates of divergence among species and within the hominid family, the emergence of modern humans.

On the other hand, paleoanthropologists use field evidence—bones, tool fragments, fossils—and geologic or radiocarbon dating techniques (assuming another form of steady rate clock) to establish emergence dates. Significant differences in the timing of human evolution result from the two techniques and hence the debate. Once students have gained a solid understanding of cell structure and DNA they may be prepared to delve further into this debate.

Of most fascination is the possibility that future studies of the mitochondrial DNA may lead scientists back along the trail of human evolution toward an
ancestral female “Eve,” breathing new life into the mythologies considered in Section 1 of this unit.

III. CHEMICAL STRUCTURE OF LIFE—THE HUMAN GENOME

Objectives  Students should be able to
1. explain the relationships among atoms, molecules, elements, and compounds.
2. explain and give examples of inorganic and organic compounds.
3. name the six most common elements in human bodies.
4. relate the characteristics and functions of the four classes of macromolecules and give examples of each.
5. explain how enzymes catalyze chemical reactions.
6. recognize the importance of nucleic acids to inheritance.
7. describe the structure of a nucleotide.
8. describe the structure and replication of DNA.
9. explain what a gene is.
10. define the human genome and explain its significance.
11. explain the significance of mutation in DNA.
12. describe the human genome mapping project.

Strategies
1. Reading, lecture, note-taking.
2. Cooperative learning in small groups to develop diagrams and concept maps.
3. Molecular model building.
4. Construction of nucleotide and DNA models.
5. Microscope slides and projector slides of human chromosomes.
6. Guest lecturers from Bios Corporation and Yale School of Medicine, Human Genetics Department on study of genomic DNA and inherited disorders.

Discussion

Molecular biology is not trivial aspect of biological systems. It is at the heart of the matter. Almost all aspects of life are engineered at the molecular level and without understanding molecules we can only have a sketchy understanding of life itself.

—Francis Crick

23
In teaching a molecular view of life to students in high school it becomes quickly apparent that, however uncertain they feel about basic tenets of evolution theory, they seem universally to accept an atomic theory of matter from previous science study. I find it useful, therefore, to provide a quick review of atoms—elements, molecules, compounds—following a basic text in biology or chemistry. It helps to have a periodic chart and to point out to students that of the some 112 known elements, 92 are naturally occurring (and quite likely have been present since the beginning of earth). Of these 92, only about 18 are usually found in living things. And among these 18, the six most essential to human life are oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorous.

Elemental atoms bond together in various combinations to form molecular compounds. Inorganic compounds such as water (H₂O) and carbon dioxide (CO₂) exist regardless of living organisms. Organic compounds are produced by living organisms and/or by synthetic means, but in all cases this class of compounds contains carbon as an essential bonding element, usually combined with hydrogen and oxygen. Generally, organic compounds are more structurally complex than the inorganics.

Carbon can combine in long chains that form the backbone of large, complex macromolecules in which the carbon atom backbone is called the carbon skeleton—appearing in straight chain or ringed form to which other atoms attach themselves.

Four groups of macromolecules are present in living systems:

1. carbohydrates (e.g., sugars, starch, cellulose)
2. lipids (e.g., fats and oils)
3. proteins (several thousand types exist made by the linking of amino acids with peptide bonds; the type, number, and sequence of amino acids distinguishes one protein from another. Specialized proteins, called "enzymes," serve as catalysts to lower the energy required for reactions to proceed within the living cell.)
4. nucleic acids (passed from one generation to another, it is nucleic acid which stores information determining the genetic characteristics of cells and organisms; nucleic acids are the macromolecules that dictate the amino acid sequence of proteins which then control all basic life processes.)

Nucleic acids are made of units, called nucleotides, joined into long chains. Each nucleotide contains three parts:

1. sugar (either deoxyribose or ribose)
2. a phosphate group (PO₄)
3. a nitrogen base—either single or double carbon ring with nitrogen and hydrogen. See diagram 3.1 for the four bases found in DNA (Adenine = A, Thymine = T, Cytosine = C, Guanine = G).

![Figure 3.1 The four nitrogen bases in DNA](image)

Ribonucleic acids (RNA) contain ribose sugar in their nucleotides while deoxyribose acids (DNA) have deoxyribose sugar. DNA molecules have two long chains of nucleotides intertwined to form a double helix. (See figure 3.2.) The backbones of the spiral are made of the sugar-phosphates while the rings are chemically-bonded nitrogen bases. Note that the bases always have very specific pairing: A to T and G to C. (This is the structure which Watson and Crick deduced in 1953.)

![Figure 3.2 Double helix structure of DNA](image)

*(based upon diagrams in Mapping Our Genes—The Genome Projects)*

The structure of DNA quickly led to an understanding of how this crucial molecule replicates itself in the course of cell division. During cell division, the DNA double helix unwinds (or “unzips”), the weak bonds between base
pairs break, and the DNA strands separate. Free nucleotides are then matched up with their complementary bases on each of the separated chains, and two new complementary, identical, double helix chains are made. Figure 3.3 illustrates the beginning of this process. Students will benefit greatly from a laboratory exercise in small groups constructing and replicating their own models of DNA.

(An extension of the exercise will allow students to construct RNA using their DNA molecules as a guide and then to show how the RNA moves out of the cell nucleus to provide the code for construction of proteins at the ribosomes.)

Figure 3.3  Replication of DNA by “unzipping” of the molecule and attachment of free nucleotides to each strand
(based upon diagrams in Mapping Our Genes—The Genome Projects)

The Genome

The genome is the total genetic material (DNA) present in a single cell nucleus. Each of an adult human’s 10 trillion cells, except for reproductive cells (gametes) and red blood cells, contains essentially the same DNA—3 billion basepairs (bp) divided into 23 pairs of physically distinct units called chromosomes.

Each chromosome has a single compressed DNA molecule whose bases average 150 million—that would be 2 inches long if released from the cells and stretched out. DNA molecules are the largest known molecules.\(^{24}\)

If all of the DNA in one person’s cells were stretched out, it would reach to the moon and back!\(^{25}\)
Chromosomes are visible under the light microscope and a set of slides is available in the Teachers' Institute Library for class use. (Magnification of 400x works well.) Stains reveal a pattern of bands on the chromosomes that reflect variations in the amount of A,T,C,G bases in regions. Differences in size and banding allow each of the 23 chromosomes to be identified and in some cases abnormalities can be spotted by eye that indicate differences in the genomes. Most DNA details, however, can only be detected by molecular techniques. Abnormal DNA may be responsible for inherited diseases or cancer.

Genes are segments of DNA (sequences of bases) which directly convey genetic information as well as the information used by cells to regulate the kind and amount of protein they make. The human genome (3 billion bp) has 50,000 to 100,000 genes. Typically, a gene may contain up to 30,000 bp, but only 10 percent of these pairs are known to contain useful information (exons), while the rest are considered to be stuffer or “junk” (introns). There are about 3,000 to 4,000 genes per chromosome.26

A government sponsored, 15-year human genome project is underway to decipher the complete code of the 50,000 to 100,000 genes—essentially to determine the exact order of the base pair sequences. To accomplish this, the genome must be broken down into genes or other fragments small enough to be clones and then identified. Next, the fragments will be arranged or “mapped” in their respective locations on the chromosomes. Finally, automated techniques will be employed to determine the base sequence of the ordered fragments. The ultimate map will be the base pair sequence for the entire human genome—a “snapshot,” if you will, of the genetic code for the “standard” human being at that moment in time.

As researching this area continues, specific human genes are being identified and mapped or located on specific chromosomes. In 1958 only a handful of gene loci were known; by 1987 nearly 4,300 genes were located.27 As any reader of newspapers can tell, new genes are being located nearly daily.

An illustrated lecture is outlined in the lesson plans to assist students in grasping the scale of the genome project. If the number of base pairs of DNA in human cells is considered roughly comparable to the number of people on earth, then mapping the entire sequence of base pairs in one cell is a task comparable to identifying every single person on earth by name and location!

When the human genome map is complete, will it match any individual exactly? No, there is simply far too much variation among specific individuals to expect 3 billion base pairs to line up exactly with the standard sequence. Since all healthy humans have essentially the same genes (only identical twins have
exactly the same genotype), the map will provide an exceptionally accurate diagnostic tool.

**How Does the Human Genome Compare With Other Genomes?**

Before much was known about the DNA sequences of genomes, it was assumed that the amount of DNA would increase in proportion to the biological complexity of the organism. Since chromosomes can vary in size, the total amount of DNA is a better indication of genome size than the number of chromosomes. Higher plants and animals do have much more DNA than lower organisms. There are, however, interesting exceptions, such as the salamander which has DNA content more than 30 times greater than that of humans, even though it is a smaller, less complex organism. Even the cells of some species of plants have more DNA than human cells as shown in the table below:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Millions of Base Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacterium</td>
<td>4.7</td>
</tr>
<tr>
<td>Yeast</td>
<td>15</td>
</tr>
<tr>
<td>Nematode</td>
<td>80</td>
</tr>
<tr>
<td>fruit fly</td>
<td>155</td>
</tr>
<tr>
<td>Chicken</td>
<td>1,000</td>
</tr>
<tr>
<td>Human</td>
<td>2,800</td>
</tr>
<tr>
<td>Mouse</td>
<td>3,000</td>
</tr>
<tr>
<td>Corn</td>
<td>15,000</td>
</tr>
<tr>
<td>Salamander</td>
<td>90,000</td>
</tr>
<tr>
<td>Lily</td>
<td>90,000</td>
</tr>
</tbody>
</table>

Mapping of human and other species' genomes will enable comparative studies to be done to determine genomic sequences or genes which are conserved among widely varied species. Even without full knowledge of the genomes, it is possible to do comparative evolutionary studies by matching a known sequence probe to the DNA of various species using well-established gel electrophoresis and hybridization techniques. The results will show degrees of relatedness or divergence among species with dramatic implications for the construction of evolutionary trees.²⁹
Within any single species, hereditary variation is the result of changes occurring by mutation—changes in the sequence or number of nucleotides—which occurs during DNA replication. Mutations formed in sex cells are inherited by offspring, whereas those that occur in other cells remain only in the affected organism. Some diseases, such as human cancers, can be caused by factors in both of these categories. Mutations can also be the result of artificial causes, such as exposure to radiation or certain chemicals. A change in even just a single base pair may modify or shut down a protein, if one is encoded in the altered region of the chromosome. More extreme mutations, involving changes in structure of a chromosome or number of chromosomes, can also occur.

In diploid cells, each DNA molecule has a tendency to undergo some modification or rearrangement with each cell division. In meiosis, two rounds of cell duplication occur, resulting in four daughter cells, each with a haploid set of chromosomes. Before the first division, each member of a chromosome pair is replicated, forming two sets of chromosome pairs. At this stage, the cell has two identical copies of maternal origin chromosomes, and two identical copies of paternal origin. An event called “crossing over” or “recombination” can occur in which one maternal and one paternal chromosome exchange corresponding sections of DNA. In this way, two of the four resulting sex cells have chromosomes with new combinations of genes and thus new combinations of traits are created.

**Conclusion**

What actually happened [in evolution] makes sense. It’s just that what actually happened is one of a billion possible alternatives... if you could play life’s tape again from any early point, you’d never get it to run exactly the same way again.

Since Linnaeus, biologists have classified animals according to similarities and differences in form and structure. These physical features were used to establish lineages—“family trees” or evolutionary relationships among species. Today, new methods of genetic analysis are challenging morphology as the key to determining family trees. The potential power of genetic techniques for evolutionary studies lies in the growing acceptance that the driving force behind structural changes in organisms is the constant miniscule molecular mutation of DNA.

The human genome as we are coming to know it is but one brief chemical moment in evolutionary time. However, it is our moment; and the scientific and technological advancements promised by a full understanding of the genome’s complexity will fuel a vigorous research effort for at least the next decade.
LESSON PLANS

Lesson Plan 1: “Tales of the Human Dawn”

Materials
Copies of Pima Indian creation myth (provided with rental of video from Smithsonian World)
Copies of glossary (provided with video rental from Smithsonian World)
Overhead transparency: “Timeline of Hominid Evolution” (also available from Smithsonian World)

Educational Themes
1. Humankind's various interpretations of origins.
3. The evidence in fossil record of early humans and theories to explain the findings.
4. Uniquely human characteristics.

Previewing Activities
1. Brainstorm characteristics that define what it means to be a fully modern human. List responses, have students divide them into two categories: physical and cultural.
2. Discuss: What do the characteristics say about Homo sapiens in comparison with other animal species? (Prior lecture on genus, species classification will be needed—students need to know we are genus Homo, species sapiens, subspecies sapiens to separate us from an earlier, now extinct group, Homo sapiens neanderthalensis.)
3. Give students copies of the glossary; preview terms which will be used in the video.
4. Review definitions of various fields of science—paleontology, paleoanthropology, archeology.

Discussion What kinds of specific information does each science contribute to our understanding of early humans? Why is it important for us to know about early history of Earth and our own species?
**Postviewing Activities for Discussion and Writing**

1. Are humans truly different from the other animals? What arguments are used to make the case for human beings' special place in nature?
2. Why have people in every culture created origin myths? What does this tradition of creation stories say about how humans view themselves?
4. Divide into groups. Have each group read a different creation myth and then present it to the class as a story or skit with interpretation of its meaning.
5. Bipedal walking, versatile hands with opposable thumbs, binocular vision, and large brain distinguish humans from other animals. To demonstrate how changing just two of these attributes changes the way we live, have each student tape his thumbs to the palms of his hands and put a patch over one of his eyes. Let them spend a few minutes in regular classroom activities. What activities are particularly difficult? What behavior adaptations are necessary?
6. Construct a wall chart of the hominid timeline. (Research may be needed——see Lambert's *Field Guide to Early Man*.)

**Lesson Plan 2: “The Children of Eve”**

**Materials**

Glossary (adapt from video, as appropriate)
Visual aids—model or overhead transparency of a cell, DNA

**Educational Viewing Goals**

1. Review Sarich and Wilson’s experiment that caused them to hypothesize that hominid and ape lines split only 4-6 million years ago.
2. Recount arguments for and against existence of a steady molecular clock.
3. List two theories that explain why bipedalism evolved.
4. Discuss why some evolutionists believe that the Neanderthals could not have evolved into the Cro-Magnons.

**Discussion**

Almost 20 years ago, Vince Sarich and Allan Wilson challenged the traditionally accepted date of 15-29 million years ago for the divergence of
human and ape lines. Have the class discuss the experiments that support Sarich and Wilson's more recent divergence date of 4-6 million years ago. What are the arguments for and against their steady clock? What is the Sarich and Wilson theory of evolution? What is their critics' theory?

**Suggested Activity** Invite a molecular biologist to visit your class to discuss what he or she does on a daily basis. Ask the speaker to bring some common tools used in his or her field of work. Where does the scientist expect his or her area of research to lead?

**Follow-up** Divide students into groups and assign each one of the recent news magazine articles listed below. The group's task is to read and discuss the article among themselves and construct a concept map to present to the class summarizing key themes in their article.

**Recommended Reading**

**Lesson Plan 3: Modeling Structures of DNA and RNA**

**Materials**
- One roll of adding machine tape, felt pens
- Stapler, scissors, masking tape for each group
- 8 different colors of construction paper to cut to about 3” x 5” pieces (for consistency in the room, assign colors to A, C, T, G, U, phosphate, ribose sugar, and deoxyribose sugar)

**Objectives**
1. Students will practice cooperative learning in small task groups.
2. Students will assemble materials to form the nucleotides needed to form DNA and RNA.
3. Students will be able to construct and sketch a model of the DNA molecule, labeling all component molecules.
4. Students will be able to demonstrate and explain replication using their models.
5. Given a DNA molecule model, students will be able to demonstrate transcription (conversion of DNA code into RNA code).
6. Students will be able to identify quickly DNA and RNA models and compare and contrast them.

**Procedures**
1. Divide the class into task teams of 3-5.
2. Each group should devise paper shapes and label them to represent models for the bases Adenine, Thymine, Cytosine, Guanine, and Uracil so appropriate pairs fit together like jigsaw pieces. (Teacher should provide a sample)
3. Decide paper shapes and colors to represent phosphate, ribose, and deoxyribose, and label “PO₃⁻,” “r,” or “d” appropriately.
5. Construct a paper model of a DNA sequence encompassing at least 15 base pairs—the adding machine tape will serve as spines of the “ladder.”
6. Once teacher has checked the original DNA, it should be “unzipped” and replicated. One of the daughter models should be hung on the wall or bulletin board.
7. The second daughter DNA should be unzipped and transcribed into two separate strands of RNA. The RNA strands should also then be taped or tacked on the wall.
8. Upon completion of constructions, the group should clean up and sit together to fill out lab report forms, answering all questions to review the work which has been accomplished.

**Debriefing** Cooperative exercises should be followed by class discussion focused on the performance of the task groups. How did the group proceed? What decisions had to be made? How? Who had good ideas? What behaviors were helpful/unhelpful? Did everyone participate?

Collect and grade the lab reports to verify content learning in the lesson. Save the models of DNA and RNA for a follow-up session in which the same teams will have a chance to use their RNA to sequence proteins in simulated ribosomes.
Lesson Plan 4: Lecture Notes: Comparative Scale of Genome

A full page illustration (in miniature below) can be easily converted into an overhead transparency to assist students in grasping the scale of the genome mapping project.

"Mapping" the human genome is a huge task which involves determining the sequence of some 3 billion base pairs in a single cell. The number of base pairs of

![Diagram of scale comparison from Earth to gene and nucleotide base pairs.]

**Figure LP-4  Comparative Scale of Genome Mapping**

DNA can be thought of as roughly equal to the total number of people on earth. Thus, if a physical map could be drawn showing the identity and location of each living person on earth, this mapping feat would be comparable in scale to what molecular biologists hope to accomplish in the next 15 years with the genome.

Using the single cell–earth and base pairs–people scales, chromosomes (50 to 250 million base pairs each) are analogous to countries, and genes (thousands to millions of base pairs) to towns. Between chromosomes and genes in size are chromosome fragments (1-50 million bp) and on the comparative scale a fragment is analogous to a county.

If students can begin to grasp the scope of the genome project in these terms, they may understand why it will take so long and why emerging technologies for automatic sequencing of portions of DNA are so useful. Questions should be raised for further exploration and discussion: Is the genome project "big science" in the classic sense of the Manhattan Project and Moon Landing of previous decades or the Superconducting Supercollider of this decade? Is the genome project worth the estimated cost of 3 billion dollars? A little research will quickly uncover strong arguments for either side of this question and an interested group of students might enjoy staging a debate on this topic for the class.

**Lesson Plan 5: “Paper Clip Plasmids” (A Hands-on Investigation of Recombinant DNA Technology)**

Although this activity is intended for students who have a good grasp of genetics, including information transfer, DNA, RNA, and the genetic code, it can also be presented to introduce students to the concepts of DNA and RNA molecular formation by pairing of bases. The manipulation of colorful chains of paper clips (“pop-beads” make an appealing substitute), following of directions to construct a letter-color “code,” removing a short sequence of code, and figuring out how to attach a portion of DNA strands to a plasmid ring may provide graphic illustration which will lead to further curiosity and inquiry as the cognitive understanding develops. And besides, it is fun!

Complete instructions for this lesson, far too extensive to be printed in this unit, are available in the flyer, “National Science and Technology Week '88: Genetic Engineering: from the Industrial Biotechnology Association,” 1625 K Street, N.W., Suite 1100, Washington, D.C. 20006; or (202) 857-0244. Materials can be obtained from any stationery store for less than ten
dollars. For advanced students or a special project, this lesson is highly recommended.

Notes

2Mark Twain, Adventures of Huckleberry Finn, 121.
3P. Dunne, “Dissent, Dogma, and Darwin’s Dog,” 84
5P. Dunne, op. cit.
7E. J. Larson, Trial and Error: The American Controversy over Evolution and Creation, 18.
8R. L. Herrmann, op. cit., 8.
10Ibid.
12Ibid.
13From general historical information in M. Bramwell, Understanding Evolution.
14W. Mayer, op. cit.
16See bibliography for recent Newsweek and Discover articles.
18W. Mayer, op. cit.
19J. Darnell, H. Lodish, D. Baltimore, Molecular Cell Biology, 11.
20Ibid.
21J. Shreeve, “Argument over a Woman,” in Discover, 54.
22Ibid., 52.
23F. Crick, What Mad Pursuit, 61.
26Human Genome Program Report, p. 124.
28Ibid.
29Ibid.
Video Resources: “Creation, Evolution, and the Human Genome”

(In just a short time since the compilation of these suggested resources, I have discovered that nearly all of the NOVA and Smithsonian videos can be obtained through public library loan systems. The Hawkhill Videos can be rented or purchased from Hawkhill Associates, Inc., 125 East Gilman Street, Madison, Wisconsin 53703. Both the feature films—“Inherit the Wind” and “Race for the Double Helix”—can now be obtained from several of the larger chains of video rental stores.)


“Children of Eve.” NOVA, 60 min., 1990. The case for human and ape divergence based on DNA studies; review of Sarich’s and Wilson’s molecular clock hypothesis.

“The Gene.” Hawkhill Videos, 60 min., 1989. Two 30 minute segments, one on the history of genetics, the other on genes and how they work. Good basic information and illustrations of DNA and genetic engineering.

“God, Darwin, and Dinosaurs.” NOVA, 60 min., 1989. Documents the creation-evolution controversy and uses the debate to explore the question, “What is science?”

“Evolution.” Hawkhill Videos, 60 min., 1989. Human evolution and family trees as seen primarily by paleoanthropologists. Interviews with Louis Leaky, Jane Goodall, and others on their field studies.

“Decoding the Book of Life.” NOVA, 60 min., 1989. Explanation of DNA as the code for all life; excellent graphics showing unwinding of DNA molecule to examine and explain base pair sequences.

“Inherit the Wind.” (feature movie) 120 min. Two versions of this movie have been made based on the play about the famous 1925 Scopes Trial. The original starring Spencer Tracy is excellent, but students may prefer the somewhat more recent remake. Good entertainment for those interested in the trial and its dramatic development.

“Race for the Double Helix.” A&E Films, 106 min., 1987. First produced by BBC as “Life Story,” this film portrays the discovery of the structure of DNA. Jeff Goldblum plays a rather manic Jim Watson, and Tim Pigott-Smith plays Francis Crick. In reviewing the film himself, Crick said that “it certainly gets [across] the obvious fact that scientific research is performed by human beings, with all their virtues and weaknesses.” Enjoyable, but students are apt to find it a bit slow paced and heavily laced with science dialogues.)
Annotated Bibliography

• indicates that the listing is recommended all or in part for students


• *Biological Science—A Molecular Approach*, Sixth Edition. Lexington: D.C. Heath, 1990. Produced by the Biological Sciences Curriculum Study (BSCS), this should be in every classroom as a reference if not the standard high school text. It is readable, well-illustrated, and filled with a wealth of valuable teaching ideas and research suggestions.


• Crick, F. *What Mad Pursuit*. New York: Basic Books, 1988. Crick’s account of the discovery of DNA, a companion piece to Watson’s earlier version. Filled with amusing anecdotes and quotable quotes as he reflects on the nature of the discovery and its significance. If you are more interested in the story than the scientific details, he even tells you which chapters to skip! (But don’t!)


• Dyson, F. *Origins of Life*. New York: Cambridge University Press, 1985. Delivered as a lecture series, this brief text is first a history of theories and experiments concerned with the origin of life and second the attempt of a new hypothesis that “life began twice”—once with nonreplicating cells, and later with genes which originated as parasites infecting the cells.


• Wambaugh, J. *The Bloodling*. New York: Bantam Books, 1989. Dramatic true story of the first murder case solved (in England) by use of “genetic fingerprinting.” The pace lags a bit and DNA fingerprints are not adequately explained, but this is a classic tale with significance for modern forensics and law enforcement.

• Watson, J.D. *The Double Helix*. New York: Signet Books, 1968. Watson’s personal account of the discovery of the structure of DNA. Lively, brash, opinionated, this account will make scientists come alive for students. Crick’s version, 20 years later, is a much more reasoned and mellowed one.


These last are two excellent reports on the progress of the government-sponsored genome mapping effort. These first reports provide a great deal of educational material and superb, usually non-copyrighted illustrations. Regular reports are mailed out on the project free to those who request them—it is worth getting on the list if you expect to teach topics in biology or genetics in the next few years.
Seminars Offered
By The Yale-New Haven Teachers Institute, 1978-1991

1978

Language and Writing
20th Century Afro-American Culture
20th Century American History and Literature
Colonial American History and Material Culture

1979

The Stranger and Modern Fiction: A Portrait in Black and White
Themes in Twentieth Century American Culture
Remarkable City: Industrial New Haven and the Nation, 1800-1900
Language and Writing
Strategies for Teaching Literature
Natural History and Biology

1980

Adolescence and Narrative: Strategies for Teaching Fiction
Art, Artifacts, and Material Culture
Drama
Language and Writing
Man and the Environment
The Present as History
Problem Solving
1981

The City in American Literature and Culture
An Interdisciplinary Approach to British Studies
Human Sexuality and Human Society
Writing Across the Curriculum
The Human Environment: Energy
Computing

1982

Society and the Detective Novel
Autobiography
The Constitution in American History and American Life
An Unstable World: The West in Decline?
Society and Literature in Latin America
The Changing American Family: Historical and Comparative Perspectives
Human Fetal Development

1983

Elements of Architecture
Greek and Roman Mythology
Reading the Twentieth Century Short Story
America in the Sixties: Culture and Counter-Culture
Drama
Cross-Cultural Variation in Children and Families
Medical Imaging

1984

Elements of Architecture, Part II
Greek Civilization
Hispanic Minorities in the United States
The Oral Tradition
American Adolescents in the Public Eye
Geology and the Industrial History of Connecticut
1985

Poetry
American Musical Theater
Twentieth Century American Fiction, Biography, and Autobiography
History as Fiction in Central and South America
Odysseys: Nineteenth- and Twentieth-Century African-American History Through Personal Narrative
Time Machines: Artifacts and Culture
Skeletal Materials—Biomineralization
The Measurement of Adolescents

1986

The Family in Literature
Writings and Re-Writings of the Discovery and Conquest of America
Topics in Western Civilization: Ideals of Community and the Development of Urban Life
The Process of Writing
The Measurement of Adolescents, II
Engineering and Science at Work: Coal Combustion and Nuclear Fission as Sources of Electricity

1987

The Modern Short Story in Latin America
Epic, Romance and the American Dream
Writing About American Culture
The Writing of History: Writing as History
Human Nature, Biology, and Social Structure: A Critical Look at What Science Can Tell Us About Society
Science, Technology, and Society

1988

Courts, Congress and the Constitution
Immigrants and American Identity
Autobiography in America
Writing About American Fiction
Hormones and Reproduction  
Aerodynamics: Its Science, Applications, Recent History, and its Impact on  
Transportation

1989

American Communities, 1880-1980  
Poetry  
Family Ties in Latin American Fiction  
Detective Fiction: Its Use as Literature and History  
America as Myth  
Crystals in Science and Technology  
Electrical Technologies: Light at Night, Microelectronics,  
        Superconductivity?

1990

The Autobiographical Mode in Latin American Literature  
Contemporary American Drama: Scripts and Performance  
The U.S. National Parks Movement  
American Family Portraits  
Genetics  
What Makes Airplanes Fly? History, Science and Applications of  
        Aerodynamics

1991

Multi-disciplinary Studies in American Regions and Regionalism  
The Family in Art and Material Culture  
Afro-American Autobiography  
Recent American Poetry: Expanding the Canon  
Adolescence/Adolescents' Health  
Global Environmental Change
Guidelines for Writing a Curriculum Unit, 1991

The Institute attaches great importance to the process for writing curriculum units, which includes a prospectus and two drafts before submission of a completed unit. These steps for writing a unit provide you the opportunity to develop your ideas with regard to the comments of your seminar leader and other school teachers, who are the main audience for whom you are writing. Because of the importance of the writing process and the care with which the Institute schedule has been designed, it is essential that Fellows meet all deadlines. Units which have not been prepared in accordance with this process cannot be accepted.

The prospectus, each draft and the completed unit should be submitted to your seminar leader by the following dates. Individual assistance with technical questions about the preparation of curriculum units consistent with these Guidelines is available by advance appointment with an Institute Coordinator in the seminar.

Unit Topic and Reading List: due April 9

Each Fellow, in consultation with the seminar leader and other seminar members, refines his or her topic and chooses basic readings for research.

Prospectus: due April 23

A prospectus of two-to-four pages describes what you intend the final unit to contain. This provides your colleagues an overview of your project.
First Draft: due May 28

This is your first draft of the prose statement of the unit’s objectives and strategies. The seminar leader provides written comments on this draft.

Second Draft: due July 2

This draft includes a rewriting of the objectives and strategies of your unit, based upon comments of your seminar leader and other teachers, and a first writing of the unit’s other elements. The draft is returned with the seminar leader’s comments.

Completed Unit: due July 31

This is the third rewriting and refinement of the prose section of the unit and the final version of the entire unit. Fellows should consult Institute instructions for typing, illustration, and use of any copyrighted material.

THE ELEMENTS OF A CURRICULUM UNIT

After reading widely about your chosen topic and participating regularly in your seminar, you should complete a curriculum unit consisting of:

1. objectives—a clear statement of what the unit seeks to achieve;
2. strategies—a unified, coherent teaching plan for those objectives;
3. classroom activities—three or more detailed examples of actual teaching methods or lesson plans;
4. resources—three annotated lists of materials you have reviewed: a bibliography for teachers, a reading list for students, and a list of materials for classroom use. You should explain in the prose section of the unit how these resources relate to your objectives, particularly if a main purpose of your unit is to develop new classroom materials such as sets of slides.

You may present the first three elements in a unified essay or in separate sections. Whatever organization you devise, the discussion of objectives and strate-
gies must be in prose, and must constitute at least two-thirds of your completed unit. Outlines, lists, and worksheets, when included, belong in the section devoted to classroom activities. In selecting examples of classroom activities, you should present methods you have developed, rather than those gleaned from other sources. Considered together, the units prepared in your seminar should reflect a variety of methods.

Remember that the main audience for your unit is other teachers. The presentation of work-in-progress in Institute seminars will provide you with responses from one group of teachers—ideas you can use in revising your unit to make it as widely useful as possible.

**USE OF COPYRIGHTED MATERIALS**

If you want to include in your curriculum unit excerpts (i.e., passages exceeding a very few lines) from copyrighted material, you should first obtain permission from the copyright owner. If use of such material is not granted free of charge, you must also obtain advance approval from the Institute for paying any fees. Copyrighted material must be properly credited in a footnote. The Institute cannot accept units which contain copyrighted material for which you have not obtained prior authorization. Because of the delays you may encounter in obtaining permission from copyright owners, you should seek such permission well in advance of completing your unit. We suggest you write for such permissions while preparing your first draft. For further information, please consult the detailed instructions and forms we provide for obtaining copyright permissions.

**THE COMPLETED UNIT**

Final units must be submitted by July 31 to your seminar leader, not to the Institute office. The unit must be accompanied by the cover sheet and proposed indexing form. Within two weeks Institute faculty members will review and then forward completed units to the director, indicating whether each Fellow has participated fully in the seminar and the writing process. Your written evaluation and request for any classroom materials you are asking the Institute to order should be submitted to the Institute office by August 15.

Upon successful completion of the seminar and the unit, and after the Institute has received your evaluation, Fellows who are in good standing will be mailed an honorarium of $1000 and may renew their University identification
and library cards for the balance of a year. Fellows should not expect these checks to be mailed before August 15. They may also petition for certification of their course of study. Any Fellow who intends to seek for Institute studies to be recognized for credit in a degree program is advised to consult in advance with the dean of the institution where he or she is enrolled.
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Support Awarded 1977-1991

The following foundations, corporations, and agencies supported the Yale-New Haven Teachers Institute during its first fourteen years:

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<th>Foundation/Money Source</th>
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<td>Harlan E. Anderson Foundation</td>
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<td>Atlantic-Richfield Foundation</td>
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